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Development and evaluation of knowledge dissemination methods for smallholder dairy farmers in Tanzania, with special reference to bovine mastitis

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Abstract

The main aim of this study was to develop and evaluate different dissemination methods for educating smallholder dairy farmers in Tanzania about mastitis. In addition, existing milking practices, and perceptions of mastitis amongst smallholder farmers were evaluated by questionnaire, whilst the hygiene of the banda, and milking equipment, were also assessed by direct observation.

Results of this study showed that, on the majority of farms, cowboys were responsible for the main dairy activities, with supervision provided by the wife of the family. In addition, twelve percent of the cowboys interviewed by the study were found to be illiterate. These results have implications for the selection of appropriate targets, and appropriate methods of dissemination, for future dissemination programmes.

Major aims of this study were to develop appropriate, and acceptable, materials for the dissemination of key mastitis facts to smallholder dairy farmers, and to then evaluate the effectiveness of these methods. Both of these aims were achieved, and dissemination materials developed by the project included videos, diagrammatic handouts, posters and pens. The impact of these methods was then evaluated and quantified using different approaches in two study areas. The first approach involved evaluation of the effectiveness of dissemination methods for increasing overall mastitis knowledge amongst smallholder dairy farming communities. This was based on further dissemination of information amongst smallholder farmers, following training of key individuals by a mastitis training course (MTC), village video screenings, and distribution of project-specific dissemination materials. Evaluation of mastitis knowledge amongst respondents was carried out by questionnaire, at intervals of one month (n=255), and sixteen months (n=192) after dissemination. Results of multilevel statistical modelling showed that one month after dissemination there was a significant positive association between the 'mastitis knowledge' of a respondent, and a respondent stating that they had learned about mastitis by 'attendance at the MTC' ($p<0.0001$), 'attendance at a village video screening' ($p<0.0035$), 'discussion with an extension officer (EO)' ($p<0.0242$), or 'from a project-specific pen' ($p<0.0036$), whilst the association between 'mastitis knowledge' and 'contact with key individuals' within the community was shown to be non-significant. Sixteen months after dissemination there was a significant positive association between the 'mastitis knowledge' of a respondent and a respondent stating that they had learned about mastitis by 'attendance at the MTC' ($p<0.0001$), or by 'discussion with an EO' ($p=0.0042$).

The second aspect of the study, evaluated the effectiveness of direct dissemination methods for increasing mastitis knowledge of a defined number of respondents ($n=280$). This involved comparing five combinations of dissemination methods to a control group, and evaluating mastitis knowledge by questionnaire both prior to dissemination, and two weeks after dissemination. Multilevel statistical modelling was used to evaluate factors associated with the overall mastitis knowledge of respondents. Results concerning direct dissemination methods, with village, farm and individual question considered as random effects, showed that the most effective methods of dissemination were 'diagrammatic handout' (Odds ratio (OR)=3.50, 95% Confidence intervals (CI)=3.10, 3.96, $p=<0.0001$), 'village meeting and video' (OR=3.22, 95% CIs=2.84, 3.64, $p=<0.0001$), 'village meeting and diagrammatic handout' (OR=3.28, 95% CIs=2.90, 3.71, $p=<0.0001$), and 'village meeting, video and diagrammatic handout' (OR=3.34, 95% CIs=2.94, 3.78, $p=<0.0001$) when compared to the control group. Significant differences between dissemination methods were also identified. A third multilevel model was used to evaluate factors associated with individual respondent's change in mastitis knowledge, defined by the 'difference between pre- and post-dissemination scores'. Results showed that respondents exposed to the dissemination methods 'village meeting and video', 'village meeting and handout', 'village meeting, video and handout' and 'handout' showed significant differences ($p<0.0001$) in pre- and post-dissemination scores of at least 10 points greater than those of 'control' group respondents.

The unexpected success of a diagrammatic handout as a dissemination method was of interest to the author, and further work to investigate this dissemination method is recommended.

A preliminary study of the 'Hawthorne effect', which investigated the impact of administration of an open ended questionnaire on a respondent's subsequent mastitis knowledge, showed no significant association.

Identification of the most effective method of dissemination varied considerably according to the individual mastitis fact, and the level of effectiveness of each dissemination method also varied for each fact.

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Glossary

AI	artificial insemination
AIDS	Acquired Immune Disorder Syndrome
banda	cattle shed
BCR	benefit-cost ratio
BW	body weight
CAHW	Community Animal Health Worker
CBPP	Contagious Bovine Pleuropneumonia
CE	Community Educator
cg	'control' groups
CI	confidence interval
CMT	California Mastitis Test
DAFCO	Tanzanian Dairy Farming Co-operative
DCT	dry cow therapy
dg	'dissemination' groups
ECF	East Coast Fever
EO	Extension Officer(s)
F1	Filial generation 1
F2	Filial generation 2
FM	Farm Motivator(s)
FMD	Foot and Mouth Disease
GDP	Gross Domestic Product
GNP	Gross National Product
HIT	Heifer in Trust
HIV	Human Immunodeficiency Virus
HPI	Heifer Project International

i/m	intramuscular
i/mamm	intramammary
kg	kilogram
km	kilometre
LSD	Lumpy Skin Disease
m	metre
MOAC	Tanzanian Ministry of Agriculture and Co-operation
MTC	Mastitis Training Course
mtindi	soured milk
MTP	Mastitis Training Program
NGO	Non Government Organisation
OR	odds ratio
PhD	Doctor of Philosophy
PIs	Principal investigators
PRA	Participatory rural appraisal
PTD	Participatory technology development
RRA	Rapid rural appraisal
SDC	Swiss Agency for Development and Co-operation
SE	standard error
shamba	plot of agricultural land on which crops are grown
SHDDP	Southern Highlands Dairy Development Project
SID	once daily
SIT	single intradermal tuberculin test
SSDDP	Small Scale Dairy Development Project
STD	Sexually transmitted disease
SUA	Sokoine University of Agriculture
T and V	Training and Visit

TBD	Tick-borne disease
TDC	Tanzanian Dairy Company
TDDP	Tanga Dairy Development Programme
TDL	Tanzania Dairies Limited
Tsh	Tanzanian shilling
TV	television
TWIT	Two Weaners in Trust
UK	United Kingdom
VAT	Value added tax
VBAHW	Village Based Animal Health Worker(s)
VIC	Veterinary Investigation Centre

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1 INTRODUCTION

1.1 Origin and overview of project

A collaborative project between the University of Sokoine, Tanzania, and the Universities of Glasgow, Liverpool and Reading, UK, was initiated in September 1998, with the aim of optimising milk production on smallholder farms in Tanzania. The project focussed on socio-economic aspects of smallholder farming, tick-borne disease (TBD), mastitis, and knowledge dissemination. Three PhD students were involved in the project, with the first investigating TBD, predominantly in the Tanga region, the second investigating mastitis. predominantly in the Iringa region, and the third (the author) investigating knowledge dissemination in both the Iringa and Tanga regions of the country. The project was undertaken in close collaboration with two non-government organisations (NGO), the Southern Highlands Dairy Development Programme (SHDDP) in Iringa, and the Tanga Dairy Development Project (TDDP) in Tanga.

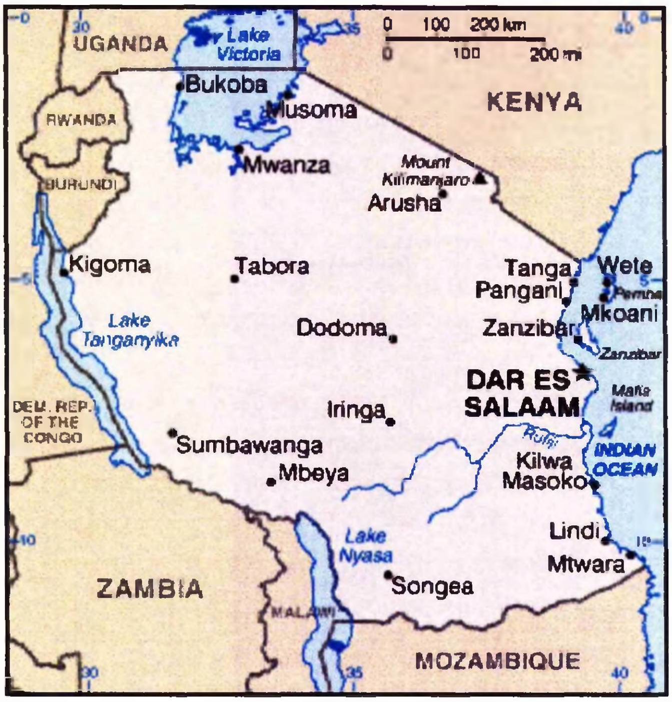


Figure 1-1: Map of Tanzania showing Iringa and Tanga, the two project study sites

The knowledge dissemination phase of the project aimed to evaluate farmer perceptions, and existing knowledge, about mastitis, to raise general awareness about the disease, to promote methods to improve udder health and milking hygiene, and to increase overall knowledge about mastitis. In addition, the project aimed to develop, and evaluate, a number of different dissemination methods, in order to identify which methods were the most effective for the dissemination of mastitis knowledge to smallholder farmers in Tanzania. The project also aimed to assess both direct, and indirect, methods of dissemination to individual farmers, in addition to the short-term and long-term impact of knowledge dissemination.

Mastitis was chosen as one focus for the project following extensive consultation with colleagues at Sokoine University of Agriculture (SUA) who felt that the disease was likely to be more prevalent than expected, due to poor awareness of the disease, poor identification of the disease, and inadequate quantification of the disease under smallholder conditions by previous published studies. At the beginning of the project, discussion with a number of key senior informants, including officials from the Tanzanian Ministry of Livestock and Water, colleagues at Sokoine University of Agriculture, and NGO representatives within Tanzania, suggested that mastitis was not a major problem on smallholder dairy farms in Tanzania, although it was acknowledged that the disease had not previously been investigated thoroughly, or quantified, under the smallholder system. As the project progressed, discussion with smallholder farmers and extension officers (EO) in the field revealed that mastitis was commonly encountered, but that the level of knowledge amongst smallholder farmers about the disease was generally poor. The role of EO is described subsequently in section 1.2.3.12 of this chapter.

Existing methods for smallholder farmers to obtain further information about animal health issues were also limited, and generally involved dissemination of information by EO, organisation of farmer field days by EO, or exchange visits to other farms. These methods were, however, heavily reliant on the enthusiasm and organisational ability of the individual EO, or the skills of the Farmer Group leader, if such a group existed in the village.

1.2 Tanzania

It was predicted in 1991 that the human population of sub-Saharan Africa will have almost tripled to 1.3 billion by 2025, resulting in 25 million more people having to be fed each year (Pritchard and Committee, 1991). The population density will have also increased substantially, with the arable land ratio falling to 0.2 hectares per person (Pritchard and Committee, 1991). It is also expected that income growth will move food preferences in favour of meat, milk and eggs. It can be predicted therefore, that there will be an increasing demand for milk, which will need to be produced under conditions of ever increasing intensification, and minimal land use.

Tanzania is one of the world's poorest countries (Mdoe et al., 1998) with a population of approximately 30 million people, 60% of whom live in rural areas below the poverty line, and approximately 10% of whom live in absolute poverty (Bagachwa, 1994, cited by Mdoe at al, 1998). Food security and poverty are, however, also common problems in urban areas, and the estimated urban growth rate of 5% per annum gives further cause for concern. Poverty indicators for Tanzania include an estimated *per capita* income of $170, life expectancy of 52 years, and access to safe water for only 49% of the population, figures which compare poorly to those of neighbouring Kenya, where the *per capita* income is estimated at $320, and life expectancy is estimated at 56 years (African Development Bank, 1998, cited by Mdoe et al., 1998). In 1999, the country had a debt estimated at $7.4 billion, and it is dependent on The World Bank and other donors for major contributions to the country's economy. Tanzania does, however, have considerable natural resources, and generates high levels of income from industries such as tourism and mining, in addition to exports of major cash crops including coffee, tea, cashew nuts, cotton, sisal, sugar, pyrethrum and tobacco (Mdoe et al., 1998). The main subsistence crops grown in Tanzania include maize, beans, cassava, coconut, legumes, and banana. Tanzania also ranks third amongst African countries in terms of livestock numbers, however low productivity results in an extremely low *per capita* availability of livestock products, which thereby inhibits poverty alleviation through generation of cash income, and improvement of the nutritional status of the population (Mdoe et al., 1998). The unit of currency in Tanzania is the Tanzanian shilling (Tsh), the exchange rate of which was approximately £1=1100 Tsh throughout the duration of the project.

1.2.1 Agriculture

Throughout the world, livestock production is considered to account for approximately 20% of agricultural output in Asia, 25% in Africa and 40% in Latin America. In these continents, usually 60-80% of the population consists of farmers. This is in sharp contrast to developed countries, such as the United States of America, where less than 3% of the population are farmers, and only 2% of the Gross Domestic Product (GDP) is attributable to agriculture (McDermott et al., 1999). Between 1980 and 1994 agriculture contributed approximately 54% of the total GDP of Tanzania, with the livestock sector contributing approximately 10% of the total GDP, and 30% of the agricultural GDP (World Bank, 1996, cited by Melewas and Rwezaula, 1998). In addition, the livestock sector provided employment to 84% of Tanzanians (World Bank 1994, cited by MOAC et al., 1998a) by generating activities such as zero-grazing, informal milk marketing, and processing of dairy products (Melewas and Rwezaula, 1998). The productivity of the Tanzanian livestock sector is, however, considered to be well below target (Melewas and Rwezaula, 1998; Mdoe et al., 1998), and this has been attributed to poor nutrition of livestock, disease challenge and poor animal husbandry practices (Melewas and Rwezaula, 1998). It is recognised that throughout Africa, increases in livestock keeping, particularly in urban and peri-urban areas, have led to large numbers of animals being kept by people without a traditional background in livestock production (Morton and Matthewman, 1996).

Livestock are the most important source of protein in Tanzania, in the form of meat, milk and eggs, and it is estimated that approximately 90% of Tanzanian households keep livestock. Reasons for keeping livestock include income generation, subsistence, and social reasons, in addition to the provision of employment, draught power, transport, manure, skin and hides, the latter of which also provides a lucrative export business. Livestock provide a regular source of income throughout the year, in contrast to crops that may only provide a lump sum after a successful harvest. This income is often used to buy food and other household needs, in addition to agricultural inputs such as fertiliser, pesticides and seeds (Melewas and Rwezaula, 1998). In addition, livestock are used as a form of saving or capital investment, as they may be purchased when household income is high, and then sold again during times of low income e.g. if the crop harvest fails, or emergency expenditure such as hospital fees are required (Melewas and Rwezaula, 1998; McDermott et al., 1999). Ownership of livestock is also commonly associated with social status, particularly in pastoral communities, and this factor may compound the problem of low productivity as it results in a low offtake of animals from traditional herds (Melewas and Rwezaula, 1998). Large numbers of people are dependent on smallholder crop/livestock and livestock systems for survival, and this trend is predicted to continue (McDermott et al., 1999)

Livestock species commonly kept in Tanzania include chickens, goats, local cattle and in some areas, dairy cattle and pigs. In 1995, the Tanzanian livestock census recorded 3.9

million agricultural households, of which 37% kept livestock, and the remainder grew only crops. This census also recorded 15.6 million cattle in approximately 1.14 million households, 10.7 million goats in approximately 1.26 million households, 3.5 million sheep in approximately 520,000 households, 435,000 pigs and 26 million poultry. The majority of the cattle recorded were of indigenous breeding, with only 246,000 exotic and exotic crossbred cattle (Bureau of Statistics, 1996). The numbers of indigenous cattle and small ruminants increased by 20% between the censuses of 1984 and 1995, however, the numbers of crossbred cattle increased by almost 50% during this time. This represented an overall annual growth rate of 6% for crossbred cattle, however, this rate of growth was thought to be much greater in urban and peri-urban areas (MOAC et al., 1998a).

1.2.2 The dairy industry

The structure of the dairy industry in Tanzania has seen many changes over the past twenty years. Previously, the socialist Government was heavily involved in the management of the agricultural sector, however, in the mid 1980's, with the advent of liberalisation, greater participation from the private sector was initiated (MOAC et al., 1998a). In the past, milk originated from the traditional cattle sector where, on average, cows yielded only a half, to one litre of milk per day (Roderick et al., 1999). In 1975/1976 the Tanzanian Dairy Farming Co-operative (DAFCO) was formed, which established large parastatal dairy farms with the aims of providing the country with milk, and directing the milk supply to the urban areas. DAFCO was also responsible for supplying individual farmers with heifers, however, in practice few were actually supplied as a result of a high mortality rate amongst youngstock. Tanzanian Dairies Limited (TDL), another parastatal organisation, was responsible for processing the milk produced, along with milk from other large private farms (MOAC et al., 1998a). The fact that DAFCO and TDL were publicly owned enterprises with salaried employees, led to a decrease in production, as there was little incentive to optimise milk production (Kambarage, personal communication 1999). The demise of these parastatal organisations led to a shift towards private enterprise, and it was widely believed that, in order to be sustainable, the Tanzanian milk industry should be reliant on milk production from privately owned farms, with a greater role in milk marketing being played by the informal sector, also known as the raw milk market. In 1994 there was a revision of the Agriculture and Livestock policy, which placed greater emphasis on expanding the size and productivity of private dairying (MALD 1994, cited by MOAC et al., 1998a). The opportunities for improving rural and economic development, and increasing welfare of resource-poor households through smallholder dairying were recognised, and resulted in support from both multilateral and bilateral donors, in addition to a number of NGO (MOAC et al., 1998a).

1.2.3 Smallholder dairy systems

1.2.3.1 Overview

McDermott et al (1999) stated that 'A number of characteristics are identified that distinguish smallholder systems from the commercial systems of developed countries, including the multiple functions livestock serve, the integrated nature of livestock activities, multiple objectives of producers and lower capacity to bear risk at the household level, as well as poor infrastructure, markets, and access to information at the community level. Smallholder farming systems in developing countries are varied, depending on ecological, demographic and socio-economic influences. In many systems, smallholdings can be considered to be livestock or mixed crop/livestock production systems whose inputs are derived primarily from the household, and whose outputs are meant to contribute to household needs. In many cases, this implies meeting only basic subsistence needs, however, in some market-oriented smallholder systems, farmers are able to earn sufficient income to pay for other non-subsistence needs such as education and building livestock and other capital assets' (McDermott et al., 1999).

Other important features, which can affect the economics of smallholder systems include: the lack of market power for both inputs and outputs, resulting from the small size of the enterprise, and limited information and weak infrastructure which leads to high transaction costs (Farrington et al., 2002). The proximity to the survival threshold faced by many smallholder households, also results in a lower capacity to bear risk, which has particular implications for household welfare if high-value livestock are lost (McDermott et al., 1999).

Smallholder farmers are often not solely interested in making maximum profit, as livestock often have multiple functions on smallholder farms, producing products such as meat, milk and hides, in addition to draught power, manure and transport. Important banking functions are also served by livestock, as they are used as asset-building tools, in addition to providing a source of regular cash and emergency funds throughout the year (McDermott et al., 1999; Melewas and Rwezaula, 1998).

1.2.3.2 Housing and fodder

In recent years in Tanzania, there has been a shift towards smallholder dairy systems, in which a family may often own a single dairy cow, plus followers, which are kept under zero-grazing conditions within the boundaries of the family's property. Zero-grazing has become popular as a method of smallholder management as it allows cattle to be kept in a very small area, a fact that is particularly important in urban areas where there is pressure on land availability. Other reasons for the introduction of zero-grazing include the control of disease, particularly tick borne disease (TBD), and prevention of environmental degradation by over-grazing, as the system prevents cattle from free roaming on the land (TDDP, 1999a).

Zero-grazed animals are kept for 24 hours per day, either tethered or free roaming, within the confinement of a banda (cattle shed) measuring $4m^2$ on average (Njau, 1983). Banda construction varies enormously, generally according to the amount of money invested by the farmer, and also the raw materials available. The main body of the banda is made up of fencing posts, or large branches of wood, whilst floors may be constructed of concrete, rubble, wood, or dirt, and are often constructed without thought for drainage, despite the fact that many become extremely wet during the rainy season (Njau, 1983). Roofs are often constructed of corrugated iron, grass thatch or banana thatch, or a combination of such materials (Njau, 1983). Many roofs are poorly maintained, with large holes present, which may further compound the problem of wet floors during the rainy season. Some bandas have separate sleeping areas for the cattle, and though bedding is rarely provided, it may consist of dried banana leaves or straw (Njau, 1983).

Fodder, consisting mainly of Napier grass (*Pennisetum purpureum*), Guatemala grass (*Axonopus larifola*), or Leucaena (*Leucaena leucocephala*), is 'cut and carried' to the cattle (MOAC et al., 1998a), either from fodder plots maintained by the farmer, or from communal areas such as roadsides, or open spaces. In addition, some crop residues such as maize stova, banana leaves, banana stems, and other cereals are fed (MOAC et al., 1998a). Some affluent smallholder farmers may also supplement their lactating cows at milking time with 1-2 kg of purchased concentrate such as maize bran or cottonseed cake, which may cost approximately 650 Tsh per kg (MOAC et al., 1998a; TDDP, 1999b). An alternative management system to zero-grazing is practised by some smallholder farmers, involving grazing cattle on communal pastures during the day, and returning cattle to the banda at night. This practise is particularly popular during the dry season, when both water, and fodder, are scarce (Akarro and Maro, 1993).

1.2.3.3 Smallholder schemes

A number of NGO have supported the development of smallholder dairying projects, both financially, and by providing support in the form of infrastructure, extension advice and education. Management practices advocated by such projects include zero-grazing of all dairy animals, bucket rearing of calves, and regular spraying of animals with acaricide.

Government control of heifer prices resulted in a thirty fold increase, from 5000 Tsh to 150,000 Tsh by 1992/1993, thus making it extremely difficult for rural farmers to invest in dairying (SHDDP, 1998a). As a result, schemes such as Heifer Project International (HPI), Heifer in Trust (HIT), and Two Weaners in Trust (TWIT) have become increasingly widespread in the country, enabling Tanzanian farmers to obtain, and maintain valuable dairy animals (MOAC et al., 1998a; TDDP, 1999b). Each of these schemes operate under different criteria, however, generally a farmer has to undergo a specified level of training, and have proved himself/herself able to build a suitably constructed banda, which may cost up to 100,000 Tsh, before being donated a cow (SHDDP, 1998a). The farmer enters into a contract with the scheme in order to ensure that the loan is repaid (SHDDP, 1998a).

The HIT scheme operates on the principle that a farmer is given a pregnant heifer, and that he/she then repays the loan by returning a pregnant heifer calf, which he/she has bred and raised, to the project (TDDP, 1999a). Alternatively, if the cow does not produce a heifer calf, or the farmer chooses to repay the credit sooner, the loan may be gradually repaid on a cash basis. The TWIT scheme operates by donating two weaner animals, of approximately six months of age, to the farmer who then raises both animals to a point where they are pregnant, and the loan is then repaid by returning one pregnant animal to the project (TDDP, 1999a). Generally, if an animal dies as a result of an accident, such as a snakebite, strangulation by the tethering rope, or unavoidable disease, the loan does not need to be repaid, and the farmer may be donated a replacement animal. If, however, an animal dies of causes that are considered to be avoidable, such as a TBD, the loan must still be repaid, and a replacement animal will not be provided.

The different NGO also ‘police’ their schemes to varying degrees, with certain projects being extremely strict and confiscating the donated animals if it is felt that the farmer has not achieved an acceptable level of management and husbandry (TDDP, 1999b). In addition, TDDP uses indices from their database such as poor youngstock growth, and long calving intervals to generate a warning 'action list' of farmers who should be visited to assess their management (TDDP, 1999b).

Many of the NGO have moved to focus their attention on the development and facilitation of Farmer Groups, in preference to providing further dairy animals. The development of Farmer Groups was identified as a recommendation in the Rapid Appraisal of the Tanzanian Dairy Subsector (MOAC et al., 1998a; MOAC et al., 1998b; MOAC et al., 1998c), and was seen as a way of producing a sustainable method of providing farmers with reliable milk outlets, in addition to the provision of inputs and services (MOAC et al., 1998a).

1.2.3.4 Cattle types and value

Cattle kept within smallholder dairying systems usually comprise exotic crossbred cattle with *Bos taurus* (e.g. Ayrshire, Holstein), and *Bos indicus* (eg. Boran, Sahiwal, Tanzanian Shorthorn) breeding. Exotic crossbred animals are believed to give an optimal milk yield (Jiwa et al., 1996), whilst conferring a degree of innate genetic resistance to endemic disease, in particular TBD and trypanosomosis (Mattioli et al., 2000; Murray and Trail, 1984; Waaij, 2001; Murray et al., 1982). The most desirable and expensive animals are high producing F1 crosses with *Bos taurus* sires, and *Bos indicus* dams, which may cost a private purchaser up to 350,000 Tsh (MOAC at al., 1998a). A number of F2 crosses, which are bred from an F1 sire and F1 dam, are also seen within the smallholder dairy industry, as are many animals with yet further dilution of the *Bos taurus* breeding.

The cost of a dairy animal is generally dependent on the degree of *Bos taurus* breeding present, concurrent with the level of milk production, thus a low producing F4 or F5 cross may cost a private buyer approximately 200,000 Tsh (Mwakalile, personal communication 1999). Considering that the average daily wage for a Tanzanian manual worker is approximately 1500 Tsh, it can be seen that dairy cattle constitute a huge financial investment for a family, however, such investment may provide important income generating opportunities (MOAC et al., 1998a). Credit is extremely difficult for an individual to obtain in Tanzania, either from dairy co-operatives or commercial banks, thus making it almost impossible to obtain a loan to purchase a dairy animal. Very few dairy co-operatives exist in Tanzania, and most banks are not interested in providing small credits to rural inhabitants. Those banks that do provide such credits generally charge extremely high interest rates, making them unaffordable for smallholder farmers (MOAC et al., 1998a; TDDP, 1999a). It can, therefore, be seen that for a family without substantial private wealth, the only opportunity to obtain a dairy cow is through one of the 'credit-in-kind' schemes, and this is reflected in the long waiting lists for farmers seeking to obtain a heifer (MOAC et al., 1998a; Akarro and Maro, 1993). In addition to the immediate economic value from milk production, cattle are also seen as a method of insurance against emergency financial needs, such as medical expenses, school fees or emergency veterinary fees for ECF treatment (Leslie et al., 1999), as the sale of a calf may generate 80,000 Tsh (TDDP, 1999b).

Manure is also an important (Melewas and Rwezaula, 1998), but often under-utilised, asset in Tanzania. Manure may be used for improvement of soil and fertilisation of crops, and may also be used for cooking and in the form of a fermented product known as 'Biogas'. Reasons for the under-utilisation of manure include a lack of knowledge about potential uses, or a lack of facilities to transport manure from the banda to the target site. In Kenya, some high production smallholder systems produce manure with a market value equivalent to approximately 28% of the value of the annual milk production on small farms (McDermott et al., 1999).

Smallholder dairy farming may, therefore, be considered to be a high-risk venture, requiring a high level of input of capital, skills and labour, whilst providing the potential for high levels of return. This is in contrast to more traditional forms of subsistence farming which may be characterised by low inputs, low outputs, and low risk (TDDP, 1997).

1.2.3.5 Reproduction

The average age of smallholder dairy cattle at first calving was 3 years, a figure which was influenced by the fact that 15% of female youngstock were stunted, and thus had an increased age at first calving, a decreased adult bodyweight, and decreased milk production (TDDP, 1999b). The average calving interval of dairy animals on smallholder farms in Tanga was approximately 501 days (TDDP, 1999b) whilst in Iringa it was 516 days (Mwakalile and Mgumba, 1998), and this problem was cited as one of the main reasons for low productivity on small-scale farms (TDDP, 1999b). Medium-scale farmers in Tanga have been shown to have shorter calving intervals than small-scale farmers, and in addition, female farmers were reported to have cows with shorter calving intervals than their male colleagues. It has also been shown that high producing cows did not have longer calving intervals than those cows with poorer production levels, however, it was hypothesised that such high producing cows were often found on farms with good levels of management (TDDP, 1999b). A number of factors may contribute to long calving intervals, however, one particular problem amongst smallholder farmers is a lack of oestrus detection (Mwakalile and Mgumba, 1998) which is often associated with a lack of knowledge about the signs of oestrus. As smallholder dairy cows are often kept either alone, or in small groups within a banda, expression of normal oestrus behaviour such as vocalisation and mounting other animals is less likely to occur than when animals are kept in large groups. Mineral deficiencies and poor nutrition, particularly during the dry season when fodder is scarce, are also thought to contribute to a lack of cyclic activity, thus further complicating the reproductive situation (Mwakalile and Mgumba, 1998).

The overall bull-cow ratio was 1:31 in Tanga in 1999, with the average bull service costing between 3,000 and 4,000 Tsh (TDDP, 1999b; MOAC et al., 1998a). Poor bull availability (Mwakalile and Mgumba, 1998), and the actual distance to the nearest bull, may also have a major influence on fertility, as some farmers have to walk their cow to a nearby village, often up to ten miles away, in order for the cow to be served, by which time she may no longer be in standing oestrus (Penman, personal communication 1999). Artificial insemination (AI) is not readily available (MOAC et al., 1998a), but is used in a very small minority of areas where certain NGO are interested in developing the service. The current infrastructure of the country, however, makes the practical day-to-day use of AI extremely difficult, with problems such as poor communications to summon the inseminator at the appropriate time, poor roads for the inseminator to reach the farm, and lack of availability of liquid nitrogen being faced.

1.2.3.6 Milk Production

A large proportion of the national milk production is from indigenous cattle, however 98% of this milk is consumed by the rural producer, and is not marketed (Ngigwana, 1990, cited by MOAC et al., 1998a). Marketed dairy production is concentrated around major cities near high human population densities, and, therefore, high densities of potential consumers, as well as in regions where the climate is conducive to keeping exotic crossbred cattle, such as the Northern Highlands (MOAC et al., 1998a).

An average milk yield of a dairy cow under smallholder zero-grazing conditions is approximately six to seven litres per day (TDDP, 1999b), and the market value of milk varies between approximately 150 Tsh/litre in the rainy season to approximately 250 Tsh/litre in the dry season, depending on the region and the purchaser (SHDDP 1998b; TDDP 1999a). There is a large seasonal fluctuation in milk price, with supply sometimes outstripping demand in the rainy season, and thus resulting in a major fall in milk price (MOAC et al., 1998a). The average milk production of a smallholder dairy cow is 1700 litres per lactation, with an average lactation length of 320 days. It has been found that the poorer producing animals are often dried off before this time, with 45% of cows in Tanga being dried off before 305 days of lactation. It has also been found that there is a trend for milk production per cow to increase according to the length of time a farmer has owned his/her dairy cattle, particularly in rural areas (TDDP, 1999b). The average annual gross margin achieved by a Tanga smallholder farmer in 1999 was 86,733 Tsh, a figure which represents a reduction of approximately 20% on the average gross margin achieved in 1998 of 113,471 Tsh (TDDP, 1999b). This decrease in gross margin can be attributed largely to a decrease in milk prices, with concurrent increase in input prices and other production costs (MOAC et al., 1998a; TDDP, 1999b). It has been shown that, despite higher input costs, urban dairying yields a higher gross margin per animal than a similar rural production system, in which the milk price is lower (MOAC et al., 1998a).

Goats are not widely kept for milk production, and their contribution to total milk consumption in Tanzania is considered negligible (Mtenga, 1993, cited by MOAC et al, 1998a).

1.2.3.7 Milk consumption

It has been predicted that milk consumption in Tanzania will rise by over 60% to 1.5 billion litres annually by 2010, however production is likely to fall short of demand, and there may be a shortfall of approximately 170 million litres annually (MOAC et al., 1998a). The low level of milk availability is attributed to the fact that cattle are not kept in large areas of Tanzania, often because of tsetse infestation, with the majority of the exotic crossbred cattle being kept in the Northern Highland region around Arusha and Kilimanjaro.

Most of the demand for marketed milk is in urban areas where there is a larger population, with a greater spending power than those in rural populations. Milk consumption has been shown to increase with income (MOAC et al., 1998a), with the average overall annual *per capita* milk availability/consumption level estimated to be 28 litres, and over 40 litres in urban areas. This figure, however, is considerably lower than that for many other sub-Saharan African countries including Kenya, where the figure is over 80 litres *per capita*. It is recognised that milk consumption is not a traditional habit, and that many Tanzanians have not acquired the taste for dairy products. In addition, consumption of milk is decreased during the rainy season, as consumers consider milk to be a 'hot weather drink' (MOAC et al., 1998b). Households involved in dairying were found to consume approximately 14 litres of milk per week, in contrast to non-dairying households where the figure was approximately 11 litres per week, however these figures were highest in dairy producing and urban areas. The majority of this milk was consumed in tea, however some households also consumed a further one to two litres per week in the form of fermented milk (mgando or mtindi) (MOAC et al., 1998a). Calves were fed approximately three litres of milk per day until three months of age (MOAC et al., 1998c).

The Government advocates that all milk is boiled before being drunk, in order to help to prevent zoonotic diseases such as tuberculosis and brucellosis, however, it is recognised that many Tanzanians do not follow this advice (Kambarage, personal communication 1999). It is, however, known that boiling may destroy some vitamins and proteins in the milk, unlike pasteurisation (MOAC et al., 1998a). The excellent nutritive value of milk is recognised in Tanzania, and some families may purchase an extremely small volume of milk each day, perhaps just half a litre, to give preferentially to their youngest children in order to improve their level of nutrition and health (Kambarage, personal communication, 1999).

1.2.3.8 Milk sales

Most milk sold in Tanzania is not controlled for safety or quality standards, and there are no incentives in place for farmers to adhere to such standards due to the lack of a price differential relating to the quality of milk (MOAC et al., 1998a; Mahlau and Hyera, 1984). Milk may be sold by a variety of methods: in urban areas it is usually sold directly to neighbours on a regular daily basis, either delivered to the house by a member of the farmer's family, or collected directly by the neighbour, usually in re-used one litre plastic water bottles. Some urban farmers sell directly to hotels and restaurants, often for a better price than that gained by selling to neighbours. Small milk vendors are also an important channel for marketing of milk, particularly in the larger cities, often purchasing between 10 and 100 litres per day directly from farmers, then transporting it, sometimes distances of 20 to 40 km, by bicycle, foot or public transport to sell to households, hotels and restaurants (MOAC et al., 1998a). In some areas, including Tanga, collection centres owned by either dairy co-operatives or private individuals, handle the majority of milk produced and may store it in refrigerated tanks before selling it locally, transporting it in refrigerated tankers to areas of high demand such as Dar es Salaam, or processing it into other dairy products such as yoghurt (MOAC et al., 1998a). High value milk products such as butter and cheese are not commonly produced, except to supply specific markets in places such as Dar es Salaam. The main reason for this is that the Government imposes high rates of VAT of 30% on all dairy products other than fresh milk (MOAC et al., 1998a), making it difficult for them to compete with imported products from South Africa and Kenya (TDDP, 1999b).

In certain areas, private or co-operatively owned milk collection centres often collect milk from a number of farmers in the vicinity. This milk is pooled in refrigerated tanks, and farmers are paid on a monthly basis, according to volume. Prior to purchase at the collection centres, the milk is subjected to a range of tests including visual inspection, filtration through a cloth, and organoleptic tests, such as the alcohol test and lactometer test, which test for freshness and adulteration with substances such as water, or skimmed milk powder. Intentional adulteration of milk is a relatively common problem in Tanzania (Ndauka, personal communication, 1999), and often results from cowboys adding water to the milk, in order to restore the original volume following the sale of some milk privately on the way to the collection centre. This water is often from a pond or river, and may even be collected using the cowboy's shoe. It is also reported that housegirls sometimes drink milk that has been left for children of the family, and then adulterate the remaining milk to restore the original volume. Vendors have also been known to adulterate milk in order to get an increase in profits. Milk composition may also be adulterated by the addition of many materials such as flour, powdered milk and sugar, to increase the volume whilst making the milk appear normal, and ensuring that the lactometer reading is correct (Ndauka, personal communication 1999).

1.2.3.9 Farm Labour

Some smallholder farms, particularly in rural areas, are run entirely as a family concern without outside assistance, and milk revenue may be the main source of income for the family. Often the wife and children of the family will assist in fetching fodder, cleaning the banda, milking the cows, or delivering the milk to the collection centre. Other farmers, particularly in urban areas, often have a full time permanent job, and keep dairy animals as an additional source of income and nutrition for the family. In these cases it is common for the farmer to employ an 'attendant', often referred to as a 'cowboy', to look after the cattle on a daily basis. The cowboys often perform the majority of the tasks associated with the care of the cows, including milking, however, varying degrees of supervision by a member of the family may also occur. It is known that many employers treat their cowboys poorly (Karimuribo, personal communication 1999, Kelly, personal communication 2002).

1.2.3.10 Socio-economic issues

It has been shown that although female members of the household, usually the wife, often do most of the work or supervision associated with the cattle, in many households it is the husband who decides how any profit from the enterprise will be spent (Maarse and Prinz, 1998). In households where this is not the case, women may use the money for everyday needs such as food or essential agricultural inputs, or may save it for large expenses such as medical treatment or school fees (Melewas and Rwezaula, 1998). Access to livestock ownership by women is often greatly limited by social or traditional factors (Melewas and Rwezaula, 1998), however, it has been found by some projects that the security of a woman improves considerably if the contract of cattle ownership is in her name (TDDP, 1996). Despite formal contracts, however, a cow which was originally donated to a female member of a family, may sometimes be claimed by male members of the household. In addition, should the husband of the family die, male members of the extended family may actually claim ownership of the animal, thus giving the women little financial security. In cultures in which cattle keeping is usually associated with male members of the household, it is recognised that farmers often need to be sensitised to female ownership of dairy cattle (Maarse and Prinz, 1998).

When seeking information from farmers concerning dairy cattle enterprises, the interview techniques employed may have a significant effect on the accuracy of data obtained (Leslie et al., 1999). For example, a husband will often insist that he, as head of the household, should be interviewed, despite the fact that he often has very little contact with the cattle. As a result, data obtained concerning the management of cattle may be largely inaccurate, and interviews should, therefore, be conducted with the most appropriate person, where possible.

Polygamy may also affect the ownership and management of dairy cattle within a family. In some polygamist families each wife lives in a different house, whilst in others the wives all reside in the same house. The latter situation, in particular, may lead to conflict over ownership of dairy cattle, with some being shared between all wives, and others belonging to only one wife. Equally, the milk and profits obtained from dairying may face the same problems of distribution within the family.

Tribal identity may also have an influence on dairying, with certain tribes such as the Maasai and Somali having a long history of indigenous cattle keeping (TDDP, 1999a). In addition, some tribes are anecdotally reported to be more work-shy than others and, therefore, less likely to be involved in dairying, which is considered to be a labour intensive enterprise (Swai, personal communication 1998). Most Tanzanians in the Tanga and Southern Highland regions of Tanzania have either Muslim or Christian beliefs, and religious affiliation may also influence matters such as polygamy, and women's status within the family, which in turn may affect dairy cattle ownership.

Private land ownership was restricted under the Arusha declaration of 1967, and although policy reforms are now in progress, land in Tanzania ultimately belongs to the Government and cannot, therefore, be inherited by family members (MOAC et al., 1998a). Various methods of land leasing arrangements exist, however, which involve an amount of money being paid to lease the land, which then enables the farmer to cultivate or use the land as they wish. This arrangement prevents the collateral value of the land being realised, discourages investment in the land, and restricts opportunities to expand land holdings (MOAC et al., 1998c).

1.2.3.11 Disease

Disease is a major threat for smallholder farmers, particularly to those with only one dairy animal, and was identified by one study in the Southern Highlands of Tanzania as the main constraint to cattle production (Akarro and Maro, 1993). It has been recognised that crossbred cattle have less genetic resistance to certain diseases, and are, therefore, more susceptible than the indigenous breeds (Akarro and Maro, 1993; Mattioli et al., 2000). Smallholder farmers stand to face major financial losses if their animal dies, particularly if their loan has not been repaid, as their main source of income is then lost (McDermott et al., 1999).

The risk of disease on smallholder farms may be influenced by management practices, livestock density, livestock movement patterns, the level of production, the degree of intensification of the livestock activity, and the importance of livestock activities within the household economy (McDermott et al., 1999).

Trypanosomosis and TBD are cited as the most important infectious disease challenges to the Tanzanian dairy herd (MOAC et al., 1998a). Disease incidence in Tanzania varies widely with region and zone, however commonly reported diseases on smallholder farms include East Coast Fever (ECF), anaplasmosis, Foot and Mouth Disease (FMD), Blackquarter, trypanosomosis, pneumonia, diarrhoea, mastitis, mineral deficiencies and helminthosis (TDDP, 1999b; Akarro and Maro, 1993). In addition, other conditions experienced include dystocia, bloat, snakebite, foreign body, and strangulation. Foot and Mouth Disease tends to occur more commonly during the dry season when movement of cattle for grazing and drinking is more common (Akarro and Maro, 1993). Vaccines are available against diseases such as ECF, FMD, Contagious Bovine Pleuropneumonia (CBPP), Lumpy Skin Disease (LSD) and Rinderpest, (MOAC et al., 1998a), however, they are expensive (Akarro and Maro, 1993), and also of variable efficacy.

Tickborne diseases are considered to be the most important causes of mortality and morbidity of livestock in Tanzania (Mukhebi et al., 1992; Latif, 1993), and ECF was ranked as the disease of the greatest economic importance in the Southern Highlands of Tanzania (Akarro and Maro, 1993). Treatment for ECF is available, but expensive, and requires rapid diagnosis (McDermott et al., 1999). Morbidity due to babesiosis and anaplasmosis is common, however, mortality due to these disease is uncommon (McDermott et al., 1999). The use of acaricide spray pumps is now common amongst smallholder farmers for tick control (MOAC et al., 1998a; Akarro and Maro, 1993), as the large communal cattle dips which were previously subsidised and maintained by local government, have largely fallen into disrepair (Akarro and Maro, 1993).

The overall mortality rate of smallholder cattle in Tanga between 1996 and 1999 was 5%, and similar figures are also reported for Iringa (Mwakalile and Mgumba, 1998), with the major disease threat being from TBD, particularly ECF, which was responsible for 35% of the deaths in Tanga (TDDP, 1999b). The overall mortality rate for calves in Tanga was 8% (TDDP, 1999b), however, mortality was considerably lower in heifer calves than in bull calves (TDDP, 1999b). This trend is widely attributed to the increased level of care given to heifer calves due to their potential value from milk and calf production, which is much greater than the comparative meat production from bull calves (Swai, personal communication, 1998).

Mastitis does occur on smallholder dairy farms, however, the insidious clinical presentation and low mortality rates associated with the disease, result in many farmers failing to appreciate the importance, and in particular the economic effects, of the disease (Njau, 1983; Machang'u and Muyungi, 1988; Mwakalile and Mgumba, 1998). It has also been observed that, in general, the lactation curves of dairy cows gradually decline following their first lactation, rather than peaking in the third or fourth lactation as would normally be expected (Kambarage, personal communication 1999). One survey in Tanzania estimated the incidence levels of clinical mastitis on medium scale dairy farms around Morogoro to be 3.9%, and the incidence of subclinical mastitis to be 67% (Machang'u and Muyungi, 1988). The incidence of mastitis is likely to be associated with the poor husbandry observed on farms, particularly irregular and incomplete removal of manure from the banda, superficial washing of the udder, use of a communal towel to dry the udder of a number of cows, and poor hygiene of the milkers (Machang'u and Muyungi, 1988; Njau, 1983). The main causative mastitis pathogens isolated in Tanzania have included *Staphylococci spp.*, *Streptococci spp.*, *Corynebacteria spp.* and coliforms (Njau, 1983; Mahlau and Hyera, 1984; Akarro and Maro, 1993; Mbise et al., 1983), with organisms isolated including *Staphylococcus aureus*, *Staphylococcus epidermidis, Streptococcus. agalactiae*, *Streptococcus dysgalactiae*, *Streptococcus uberis, Escherichia coli, Corynebacterium spp.*, *Micrococcus spp.*, *Proteus spp.and Pseudomonas aeruginosa* (Njau, 1983; Kambarage et al., 1996). Treatment of mastitis in Tanzania has often been unsuccessful, resulting in induration of quarters, or even total loss of udder function (Mbise et al., 1983). It has been recommended that testing of various interventions for the control of bovine mastitis under smallholder dairying conditions should be undertakenm (Akarro and Maro, 1993). It has also been suggested that the incidence and impact of production diseases such as mastitis and lameness will increase as milk production levels increase over time (McDermott et al., 1999).

Zoonotic diseases of particular importance in Tanzania include tuberculosis, brucellosis and enteritis. *Mycobacterium bovis* has public health implications due to the fact that a common route of human infection is through drinking infected milk (Sinha, 1994, cited by Kazwala et al., 1998). One study, covering the whole of Tanzania, found the incidence of *Mycobacteria spp.* positive milk samples to be 1.5 % (Mahlau and Hyera, 1984), whilst another study in a high risk area for tuberculosis demonstrated that 3.9% of milk samples screened were positive for *Mycobacteria spp* (Kazwala et al., 1998). A further study, which used the single intradermal tuberculin test (SIT) to establish the prevalence of bovine tuberculosis, found that 0.9% of dairy cattle tested in Dar-es-Salaam were positive, and 1.2% were doubtful, whilst 0.6% of zebu cattle tested in the Lugoba coastal region were positive, and 6.8% were doubtful (Weinhaupl et al., 2000). Whilst these incidence levels are relatively low, the common practice of pooling milk in Tanzania results in increased concern, as it has been shown that one cow can excrete enough viable bacilli to contaminate the pooled milk of up to 100 cows (Kleeburg, 1984, cited by Kazwala et al., 1998). The increase in prevalence of Human Immunodeficiency Virus (HIV) in Tanzania also gives cause for concern, as immuno-compromised patients are more susceptible to infection with *Mycobacteria spp.* Brucellosis may also be transmitted by the consumption of raw milk or milk products, and one study in the Lake Victoria zone of Tanzania, executed under the Tanzanian Ministry of Agriculture's directive, screened 13078 cattle using the serum agglutination test (SAT), and found a prevalence of 6.3% amongst exotic and exotic cross animals on large scale dairy farms, and 15.8% amongst dual purpose (milk and beef producing) animals on ranch units (Jiwa et al., 1996). A further study showed the prevalence of brucellosis amongst dairy cattle tested in Dar es Salaam to be 14.1%, and that amongst zebu cattle in Lugoba district to be 12.3% (Weinhaupl et al., 2000). In addition, an abattoir survey in the Southern Highlands of Tanzania revealed a prevalence of between 6-26% of positive reactors (Akarro and Maro, 1993). It is believed that brucellosis may be mis-diagnosed or under-diagnosed in human cases, as the clinical signs with which patients present, are very similar to those of malaria or typhoid, both of which are common diseases in Tanzania (Kambarage, personal communication 1999). There are no effective control programmes for either brucellosis or tuberculosis within Tanzania (Mwakalile and Mgumba, 1998). Gastroenteritis is a further zoonotic disease that may result from the consumption of contaminated milk, particularly if the milk contains toxins produced by bacteria such as *E. coli* or *Staph spp.* Antibiotic residues in milk are also an area of concern for human health, as there is a danger that these could lead to antibiotic resistance amongst humans. It is widely recognised in Tanzania that recommended drug withdrawal times are often not adhered to, and in addition, high levels of *in-vitro* resistance to penicillin-G and novobiocin have been demonstrated (Akarro and Maro, 1993).

Six percent of the Tanga dairy population were slaughtered in the year between 1996 and the end of 1997. The most common reason for slaughter was for meat production, which accounted for 59% of those slaughtered. The vast majority of animals slaughtered for meat were bulls, with an average age of 5 years for breeding bulls, and 2 years for fattening bulls. In addition, 15% of animals were slaughtered because of disease, and a further 26%, of average age between 6 and 7 years, were slaughtered because of poor reproduction or poor milk production (TDDP, 1997).

1.2.3.12 Veterinary Care

McDermott et al. (1999) state that 'Economic issues related to the delivery of veterinary services in Africa have raised interest in recent years, particularly with the downsizing of State Veterinary Services and the increasing reliance on private services'.

In the past, the Government of Tanzania provided extension services that included clinical and preventive veterinary health services (MOAC et al., 1998a) such as treatment for ECF, access to communal dip tanks, and vaccination against FMD. These services gradually deteriorated as a result of budgetary constraints, and increasing privatisation (MOAC et al., 1998a), and are currently provided by EO, or vets, at a private cost to the farmer.

A number of private veterinary surgeons operate in urban areas, and these numbers have increased as a result of the increase in private enterprise seen since the abolition of socialism in the 1980's. Veterinary surgeons have received a full undergraduate training of five years duration, and usually operate a 'call-out' service for examining animals, for which they will charge a consultation fee plus any additional treatment charges. Veterinary surgeons also run veterinary input shops, supplying EO and farmers with expert advice and inputs such as acaricides, antibiotics and anthelmintics.

Extension officers provide the majority of veterinary care, charging a fee for examining the animal, and then a further charge for any pharmaceutical treatment administered. These individuals are 'paravets' who have usually completed a two-year diploma in either animal health or animal production, and are then employed by the Government to provide extension advice to farmers within a specified area. Extension Officers are also often employed by NGOs to assist with projects, and to help advise farmers enlisted onto their programs. They may, therefore, receive a salary from a number of different sources, which may cause a potential conflict of interest in certain situations.

One major concern in Tanzania is the shortage of extension workers in certain areas, particularly those in rural locations (Akarro and Maro, 1993). This has prompted a number of projects to focus on the development of Community Animal Health Workers (CAHW), particularly in amongst pastoral communities in rural areas where extension services are scarce. Community Animal Health Workers are selected members of the community, who are given often two weeks of basic training in animal health and the correct administration of drugs in order that they may provide basic animal health care to animals within their community (Catley, 1999). Community animal health activities aim to make the best use of indigenous animal health knowledge and skills, and encourage communities to identify their main animal health problems, and increase the general involvement of the community in animal health programmes (Catley, 1999). In addition, selection of appropriate members of the community to receive training as a CAHW is done by fellow members of the community, and one study found that the criteria used to do this included the ability to read and write, integrity, honesty and an interest in livestock health (Daborn et al., 1999). Concerns surrounding reliance on CAHW for the provision of animal health services focus mainly on the low level of training that they receive, however, with the gradual withdrawal of Government support for extension services in Tanzania, CAHW appear to provide the 'best alternative' in rural areas where EO are extremely scarce and no other formal animal health services exist.

1.2.3.13 Veterinary inputs

Over 95% of veterinary inputs are imported into the country, and this, in addition to the devaluation of the Tsh, has resulted in high costs for such inputs (Akarro and Maro, 1993). Market access is also crucial in determining demand and prices for livestock products, and the costs and supply of inputs. Poor infrastructure and public services may also contribute to the limitation of input and output markets, and this is often a particular problem in rural areas (McDermott et al., 1999). Further problems associated with veterinary inputs include the fact that shortages of veterinary input supplies may be experienced for prolonged periods of time (Akarro and Maro, 1993), and many inputs are supplied in package sizes which are appropriate only for large, or medium-scale, farmers. Inappropriate package sizes result in inputs being unaffordable for smallholder dairy farmers, and may result in packages being subdivided or 'split' in order to provide a volume that is suitable for a smallholder farmer, although some veterinary input shops are reluctant to do this. The splitting of original drug packaging may, however, lead to further complications, as the drug may be decanted into an unmarked container such as a soda bottle, without labelling to identify the product, or instructions to inform the user of the correct dilution or dosing instructions. A further problem with many of the veterinary products available to smallholder farmers in Tanzania is the fact that a number of products only have English instructions, and no Kiswahili translation. In addition, instructions are usually written in text, rather than diagrammatic form, making it difficult for users with poor literacy skills to comprehend them. It has also been found that many farmers assume that the dilution instructions for all acaricides are the same, thus when a different brand of acaricide is purchased, it is often diluted according to the instructions of a product purchased previously (Swai, personal communication 2002). It is also known that 'fake' veterinary products are becoming an increasing problem in Africa (Holmes, 1997), and that many are imported into Tanzania from countries including Malawi and Kenya (Kambarage, personal communication, 1999).

When compared to large-scale farms, the low degree of intensification on smallholder farms, generally results in a lower demand, and higher transaction costs, for specialised services such as veterinary advice and treatment. Households in intensive large-scale systems also tend to have a greater need for decision-making tools than smallholder farmers. Poor flows of information to smallholder farmers often result in animal health management decisions being based on very limited information. Other constraints faced by smallholder farmers include their limited opportunities to learn by direct observation of successes on other farms, poor extension and information systems, and lack of training or practice in decision-making (McDermott et al., 1999). McDermott et al (1999) state that 'Improved information flow can be a powerful tool to support animal health decisions on smallholder farms'.

1.3 Education

1.3.1 School education in Tanzania

Primary school education in Tanzania, known as 'standard grade' education, is usually received between the ages of six to twelve years, and the primary school enrolment rate was 70% in 1998 (African Development Bank, 1998, cited by Mdoe et al., 1998). Standard grade education used to be provided free of charge during the socialist period of government, however the cost of primary school education subsequently increased to approximately 4000 Tsh per pupil per year (Leslie et al., 1999). Secondary school education, known as 'form level' education, is usually received between the ages of twelve to eighteen years. One report suggests that between 1985 and 1995 only 12% of the population continued from primary to secondary school (Swainson, 2000), whilst another 1998 report suggests that only 5% of the population received secondary school education

(African Development Bank, 1998, cited by Mdoe et al., 1998). A number of factors may contribute to the level of schooling which an individual achieves, including location, with rural areas having poorer access to schools and particularly secondary schools; gender, more boys than girls are generally sent for schooling by their families, however boys have a higher drop out rate from primary school than girls due to their increased opportunity in the informal employment sector (Swainson, 2000); family wealth, if the family is poor many of the children will be sent for manual labour in order to create increased income for the family. One report suggest that 17% of the Tanzanian population are illiterate (Swainson, 2000), whilst another suggest that this figure is nearer 32% (African Development Bank, 1998, cited by Mdoe at al., 1998), and it has been suggested that there is a higher overall illiteracy rate amongst women than men (Swainson, 2000).

One study amongst small-scale farmers in Tanzania revealed that 78.9% had received basic standard level education, 8.5% had received education beyond standard level, and 2.8% had received no formal education of any kind (Dulle and Aina, 1999).

1.3.2 Methods of education

Education methods for disseminating knowledge range from traditional didactic methods such as formal lectures and tutorials, through to participatory methods such as group discussions, matrix ranking and problem solving exercises, and informal methods such one-to-one discussion, and direct observation of neighbours or colleagues. In addition, the use of multimedia as an education tool is becoming increasingly popular (Leggat, 2000; Garforth, 1985), although research into this subject is at an early stage (Mayer, 1999). Bessoff (1995) states that successful educational programs incorporate lecture, audio-visual materials, group learning activities and 'hands-on' sessions to increase learning, however the most important factor is that the educator is enthusiastic and knowledgeable and makes the programs interesting (Bessoff, 1995). It has also been suggested that adults tend to learn best when there is an actual need for them to know the information presented, and are more receptive to the material when it is directly applicable to their situation, and mastery of the material is seen as a means of achieving a specific goal (Bessoff, 1995).

Visual literacy is an important consideration when designing a knowledge dissemination program involving diagrams, and refers to the ability of an individual to accurately understand and interpret an image presented to them (Linney, 1995). If the individual does not understand common pictorial conventions, they may see an image as simply a collection of lines, shapes, tones and colours on a flat piece of paper (Linney, 1995). Common difficulties encountered by individuals who are not visually literate, include a failure to understand perspective, or pictorial conventions relating to scale, size, movement, and sequences of pictures (Linney, 1995; Byram and Garforth, 1980). Illiterate individuals have been shown to have particular difficulty in interpreting a sequence of pictures (Byram and Garforth, 1980).

A variety of education methods have been used by previous projects to disseminate knowledge. These methods are discussed more fully in the introduction to Chapter 3, but include video (Yuan et al., 2000; Sweat et al., 2001; Windsor et al., 2000; Torabi et al., 2000; O'Donnell et al., 1998), radio (de Silva and Garforth, 1997; Gathu, 1998), drama (Harvey et al., 2000; Mitchell et al., 2001), training of key individuals as community educators (Mitchell et al., 2001; Navarro, 1989) and the use of leaflets (Mitchell et al., 2001) or posters (Oladepo et al., 1996). Limited references are, however, available which evaluate the effectiveness of different dissemination methods in developing countries, particularly in the field of animal disease. In addition few studies have focussed on community–based settings involving the training of key individuals who are then responsible for further training of individuals in the community (Mitchell et al., 2001).

1.3.3 Knowledge uptake

Research into knowledge uptake and learning has often focussed on schoolchildren in developed countries, and limited published work was found concerning the impact of different dissemination methods on adult learning in developing countries. One study in India investigated factors influencing the knowledge level of farmers on low cost technologies in paddy, and found that the main factors which influenced knowledge level were farming experience and economic motivation, whilst other factors which were shown to have a significant positive correlation with knowledge level included age, education, social participation, mass media exposure, extension agency contact, and scientific and risk orientations (Krishnakumar et al., 2000). One study in Tanzania, which aimed to provide training in health, water and sanitation at the grassroots level, encountered a number of difficulties which prevented the achievement of all the project goals, and suggests that future project should incorporate a design in which the community and the facilitator can assess and analyse their problems (Kweka, 1994). A further study in Tanzania, concerning transmission of eye disease (particularly blinding trachoma), showed that neighbourhood meetings were effective in transmitting information to the community that childrens' faces should be kept washed and clean in order to prevent transmission of eye diseases (Lynch et al., 1994). One German review of different approaches to the education of children, young people and adults in developing countries concluded that primary school education contributed most to further education and rural development, and that elementary education of adults showed limited success (Buchholz, 1994).

It is thought that adults are often taught like children because adult education methods are based on child learning theories (Knowles, 1988). Knowles (1988) suggests that adults bring motivations, goals, expectations and experiences to a learning situation that differ greatly from those of a child, and techniques used in adult education should therefore allow for such differences. It has been stated that adults learn best when there is a need to know the information presented, and are also more receptive to material when it is directly applicable to their situation (Bessoff, 1995). It has also been shown that different levels of motivation may lead to different types of cognitive processing (Kruglanski, 1990, cited by Nuthall, 1999).

Nuthall (1999) discussed the learning ability of schoolchildren, and suggested that this was strongly influenced by classroom experiences, including the student's ability to understand what was expected from a classroom teaching exercise, and also their level of interaction in the class. In addition, connection with existing knowledge has been shown to be important in enabling understanding of new experiences (Alber and Hasher, 1983, cited by Nuthall, 1999; Derry, 1996, cited by Nuthall, 1999). It has also been shown that three to four separate interactions with relevant information are required for a new knowledge construct to be created, and that during the time new information is held in the working memory, it is integrated with other relevant information and background knowledge (Nuthall, 1999). The lifespan of the working memory has been debated, however one study showed that it had a lifespan of approximately two days. The same study showed that new information must be encountered on three to four separate occasions, within a period of approximately two days, in order for the information to be transferred to the long-term memory (Nuthall, 1999).

The importance of verbal and visual representations to learning has also been investigated, and it is thought that humans have separate verbal and visual information processing systems (Clark and Paivio, 1991, cited by Mayer, 1999; Paivio, 1986, cited by Mayer, 1999). One theory concerning meaningful learning states that 'meaningful learning involves active cognitive processing in which learners select relevant information, organise it into a coherent representation, and make connections between visual and verbal representations and prior knowledge' (Mayer, 1999). Studies have also shown that learning is enhanced when both visual and verbal information about a subject are presented, and is further enhanced when these two forms of information are presented simultaneously (Mayer, 1999).

1.3.4 Extension

In many countries, both in the developed and developing world, knowledge dissemination about agriculture, including both livestock and crop systems, is referred to as 'extension'. A farmer may receive extension advice from a range of sources, including individuals described as EO or 'extension agents'. Extension agents are the traditional providers of information to farmers in developing countries, and are considered by many to be the most effective method of disseminating agricultural information (Dulle and Aina, 1999). Agricultural extension has, however, also been widely criticised (Feder, 1984, cited by Dulle and Aina, 1999; Aina, 1990, cited by Dulle and Aina, 1999; Sturges and Neill, 1990, cited by Dulle and Aina, 1999; Sheba, 1997, cited by Dulle and Aina, 1999) due to reasons such as a lack of extension staff, attempts to disseminate excessively technical packages, and the slow rate of knowledge transfer from researchers to farmers, via extension agents. In Tanzania, the core funding of agricultural extension is provided by the Government, however this funding has gradually being withdrawn, and the provision of funding by NGO and other organisations has become increasingly important. In recent times it has also been seen that EO have increasingly charged farmers private fees for their services.

In many countries, agricultural extension services have developed around crop production, and few countries can afford to have a separate livestock production extension service (Morton and Matthewman, 1996). It is stated that, in Tanzania, there is a lack of knowledge about the most appropriate methods of delivery of effective extension services (MOAC et al., 1998b). Methods such as television, radio and newspapers are considered to be generally inaccessible to farmers, largely due to the unavailability of such technologies to most rural farmers, however, the use of newspapers is additionally constrained by farmers' low literacy levels (Aina, 1995, cited by Dulle and Aina, 1999).

A study with small-scale farmers in Tanzania revealed that 60.3% had never attended an extension meeting, 58.7% had never participated in a field day, 52% had never listened to a radio program, 46.5% had never been visited by an extension worker, and 69% had never read extension pamphlets or bulletins (Mattee, 1989, cited by Dulle and Aina, 1999). In contrast, a further study with small-scale farmers in a different area of Tanzania found that 88.7% claimed to attend extension meetings regularly, 83.1% had been visited by an EO, 74.6% reported to have visited a fellow farmer to seek information, whilst all respondents claimed to have never, or rarely visited an agricultural library (Dulle and Aina, 1999). Dulle and Aina (1999) recommended that other agencies, in addition to extension organisations, should be actively involved in the provision of information to farmers, whilst Morton and Matthewman (1996) suggested that systematic procedures should be used to turn research findings into extension messages.

1.3.5 Hawthorne Effect

The concept of the 'Hawthorne Effect' is based on the premise that the behaviour of a subject during the course of an experiment can be altered by their awareness of participating in the experiment (Jones, 1992). The concept is named after the Hawthorne telephone equipment plant in Chicago, where original studies on work performance took place in the 1920's and 1930's which involved evaluating the influence of a number of physical factors, such as lighting levels, length of the working week, and timing of rest periods, on the productivity of factory workers (Roethlisberger and Dickson, 1939, cited by Holden, 2001). A number of recent medical studies (Campbell et al., 1995; Holden, 2001) have shown that the Hawthorne effect does exist, particularly in reference to changes in prescribing practices when subjects are under audit (Holden, 2001). Jones (1992), however, studied original data from the Hawthorne plant, and concluded that the data showed slender, or no, evidence of a Hawthorne effect.

In this study, it was hypothesised that the act of administering a pre-dissemination questionnaire to 'control' group respondents could influence subsequent levels of mastitis knowledge. Although this pre-dissemination questionnaire comprised open-ended questions to which volunteered responses were recorded, it was hypothesised that administration of such questions could lead to an increased awareness of mastitis, and could stimulate a respondent to discuss, or seek further information, about the subject.

1.4 Aims

This study aimed to evaluate existing perceptions and knowledge about mastitis, and existing practices concerning udder health, milking, and banda hygiene on smallholder farms. In addition, the project aimed to develop dissemination materials that were appropriate, and acceptable, and to then evaluate and quantify the effectiveness of these methods for the dissemination of mastitis knowledge to those involved in the care of dairy cattle on smallholder farmers. The author hypothesised that the existing level of knowledge about mastitis may be generally poor, and that a number of farmers may be unable to recognise mild clinical signs of the disease such as clots in the milk. In addition, the author hypothesised that a number of study respondents may have limited literacy skills, and that dissemination materials comprising visual or pictorial information, with minimal text, would therefore be important. The author also hypothesised that video would be likely to be a popular and effective dissemination method.

Throughout this study, direct dissemination refers to dissemination of information by the project to an individual, via direct methods such as attendance at a village meeting, observation of a diagrammatic handout, or attendance at a video screening. In contrast, indirect dissemination refers to the propagation of information throughout a community via methods such as training of key farmers, distribution of posters, and discussion between fellow farmers.

2 EXPLORATORY STUDY

2.1 Introduction

Rapid rural appraisal (RRA) and Participatory rural appraisal (PRA) methods have achieved popular acceptance since the late 1970's as a relevant, efficient, and cost-effective alternative to the formal survey for developing an understanding of farming systems and planning experimental programs for farmers (Adams et al., 1997; Franzel and Crawford, 1987). Rapid rural appraisal methods tend to be verbally based, with outsiders or researchers taking the most active role, whilst PRA methods tend to be more visually based, with local people taking the most active role (Chambers, 1994). Participatory rural appraisal is founded on the philosophy that local people should be fully involved in, and in control of, the monitoring process of a study if they are to believe in, and make use of, the results. Rapid rural appraisal and PRA techniques, which include semi-structured interviews, wealth ranking and matrix ranking, can be used to identify the resources, livelihood, problems, opportunities, and socio-economic condition of villagers (Gallardo et al., 1995). It should, however, be noted that certain characteristics of these methods render the information obtained inaccurate for statistical analysis. Firstly, farmers are not randomly selected, and, therefore may not be a true representation of the group; and secondly, questioning is not standardised, thereby making it difficult to generalise across the farmers interviewed (Franzel and Crawford, 1987).

Semi-structured interviews are used to gain information about topics of interest in an informal manner. Discussion is initiated with open questions, and respondents' answers are then used to stimulate further discussion, and probe specific areas. Although the open questions cover the broad topics of interest, the semi-structured discussion method, in which one answer leads on to further discussion, means that no two respondents will discuss exactly the same topics, and a range of information will, therefore, be gathered.

Benefit-cost ratio (BCR) is used to give an indication of the amount of economic return an enterprise can generate per unit of investment. These are calculated by dividing the value of the returns by the value of the costs, which yields a number representing the relative sizes of the benefits and costs (Marsh, 1999). One disadvantage of BCR is that it provides no indication of the scale of investment involved in the project, which may be an important consideration when available funds are limited (Marsh, 1999), however BCR does provide a crude economic indicator of the profitability of an enterprise.

In most communities wealth status is the single most important determinant of producer behaviour and family well-being (Grandin, 1988). Wealth ranking is a method which elicits definitions of wealth and poverty from the community itself, and provides categories of relative wealth into which all households within the community can be placed (Watson, 1999; Selener et al., 1999b). In contrast to many conventional surveys, in which researchers choose the criteria of interest, wealth ranking is based on criteria volunteered by local people (Scoones, 1995). Wealth ranking is also a fast and effective way of gaining socio-economic data on small, rural communities, thereby providing an accurate basis for further investigations (Grandin, 1988) and generating useful poverty indicators (Orr et al., 1996). The technique allows researchers to identify the ways in which rich and poor households within an area differ, in addition to the relative wealth status of each household within the selected community (Grandin, 1988). The overall aim of wealth ranking is to achieve stratification of households based on their general economic well-being, which then allows examination of each stratum to identify differences in access to, and management of resources (Carter, 1993). Previous wealth ranking exercises in Zimbabwe have shown individual rankings to be highly correlated with livestock ownership, farm asset holdings, crop harvests, and crop sales (Scoones, 1995), and another study also showed the clearest manifestation of wealth to be cattle ownership (Carter, 1993). It has also been shown that a significantly greater proportion of female headed households are ranked in the poorest income category (Noel, 1997). Wealth ranking provides an accurate indicator of relative wealth, and can be a useful complementary method to be employed alongside survey assessments (Scoones, 1995). In addition, qualitative discussions during wealth ranking exercises can reveal details of the historically, socially and economically constructed understandings of wealth and well-being (Scoones, 1995). It is recognised that a particular strength of wealth ranking is it's ability to adapt to local circumstance, however in turn, this sensitivity limits meaningful cross-regional comparison (Adams et al., 1997), and the technique only generates intra-community information (Watson, 1999). This suggests that wealth ranking exercises may be of little value in areas where respondents are unfamiliar with their neighbours, or their wealth indicators, which may occur in many urban areas. It is important that the results from wealth ranking exercises in one area are not simply extrapolated to other areas.

Matrix ranking involves using a visual matrix to facilitate the identification and analysis of preferences concerning issues of interest. The exercise usually involves a group of respondents, who volunteer their own issues of interest, rather than topics being rigidly specified by researchers. A matrix is designed to include a particular topic, possible alternatives, and the criteria used to evaluate each alternative (Selener et al., 1999a). For example, the main disease constraints faced by farmers e.g. ECF, helminthosis, anaplasmosis, can be listed in rows of the matrix, and the reasons for their importance e.g. cost of treatment, level of mortality, loss of production, can be listed in columns of the matrix. Each square within the matrix is then discussed, and compared to other squares. The discussion surrounding the exercise can also be an important output, as it provides insight into farmers' perceptions and preferences.

2.2 Aims

The exploratory study, carried out in both Tanga and Iringa during the initial stages of the project, aimed to gain a general overview of smallholder dairying in Tanzania, and the importance of dairying to the household. Areas of interest included the role of dairying in smallholder households, patterns of expenditure of dairying profit, and other sources of income for smallholder farmers, many of which have already been published (Leslie et al., 1999). Other areas of interest, which were particularly relevant to the subject 'knowledge dissemination to smallholder farmers', included farmer perception of cattle disease, particularly mastitis, farmers' strategies for the control of disease, identification of common farm practices carried out on smallholder farms in relation to milking and milk preparation, identification of the household member responsible for dairying activities, in order to identify target groups of individuals and target issues for subsequent dissemination exercises.

The exploratory study, aimed to provide background information about smallholder dairy farming using a combination of classical survey methods and RRA and PRA techniques, in addition to identifying, comparing and complimenting other socio-economic work already undertaken by other NGO in the study areas. In addition, the exploratory study visit provided the author with the opportunity to visit a number of smallholder farms, which enabled identification of common dairying practices, and identification of the household member responsible for these practices, in addition to observation of the living conditions, and material goods contained within the homes of smallholder farmers.

2.3 Methods

The exploratory survey was carried out by a team of four individuals, who visited the two project sites, Iringa and Tanga, over a five-week period during October and November 1998. The initial weeks were spent identifying and collating data already collected from secondary sources, and meeting key informants, including SHDDP and TDDP colleagues, local government officials, extension staff, village elders, and farmers in some of the different agro-ecological zones. Discussions with key informants influenced the areas and farms visited in the subsequent weeks of the study.

A number of techniques were used to obtain information relevant to the study, including informal discussion, semi-structured interviews, interviews with EO, wealth ranking, matrix ranking and calculation of BCR. As PRA techniques were being, farmers and households were strategically selected, rather than randomly selected, in order to represent a broad spectrum of farming abilities, as well as those with mixed crop, and off-farm incomes. Informal discussion with a number of individuals yielded information concerning a wide range of issues concerning smallholder farmers and their families. Respondents included formally selected key informants, as well as a number of informants encountered by chance during the course of the study. Interviews with EO gained information about the main diseases seen in the study areas, the recommended use of veterinary treatments, and perceptions of EO concerning the main constraints facing smallholder farmers. Semi-structured interviews were conducted with 52 farmers from both project sites, selected by key informants to provide an overview of good, average and poor dairy farmers, in addition to those with alternative sources of income to dairying. Semi-structured interviews were used to gain information concerning household activities, enterprises, resource use, income, and understanding of disease. The interviews followed the guidelines of an open-ended questionnaire, which was piloted on five farms in Iringa. As four different team members, with differing degrees of experience in PRA methodology, were responsible for conducting the semi-structured interviews, it was decided to use an open-ended questionnaire in order to maintain the consistency of information collected. During the interviews, respondents were encouraged to elaborate and expand on their answers wherever possible, and answers given were used to lead into further related discussion.

Wealth ranking exercises were undertaken in three rural villages in order to establish fellow villagers perceptions concerning the level of wealth of dairy cattle owners. The villages were selected by key informants within either, SHDDP or TDDP, on the basis of presence of an active Farmer Group, or likely compliance with the exercise. Boza village had 76 households, of which 13 were dairy farmers, whilst Shebomeza had 107 households of which 49 were dairy farmers, and Lulanzi had 480 households of which approximately 20 were dairy farmers. The exercise involved a group meeting, to which approximately 15 local villagers, both cattle owners and non-cattle owners, were invited. Following introductions, which included stating the number, if any, of cattle owned, and the length of time of ownership, a full explanation of the aims and concept of the exercise was given. Participants were then asked to discuss factors that contributed to the wealth and general ability of a household, such as a thatched roof on the house, income from a cash crop, or ownership of a bicycle. These discussions then lead to the identification of five different wealth groups, for which applicable abilities and conditions were defined. Participants were then divided into groups of two or three, given a complete list of villagers' names, and, using the criteria previously established by themselves, asked to place each villager, including themselves, into one of the five wealth groups. The results from each of these groups were then compared, and discussed, by the entire group until overall agreement was reached concerning the wealth group identified for each farmer.

Matrix ranking exercises were used in two villages to establish farmers' perceptions about diseases of cattle. Villages were, again, selected by key informants within SHDDP and TDDP on the basis of an active Farmer Group, or likely compliance with the study. Madanga, a rural village in Tanga region, was known to have had particular problems with trypanosomosis and TBD in cattle in the past. Lulanzi, a rural village in Iringa region, had suffered numerous losses in the past due to TBD, mainly as a result of the phasing out of government dipping schemes and inadequate provision of acaricide to the then village-owned herd. Meetings were conducted in a similar manner to those of the wealth ranking exercises, and consisted of group meetings to which all cattle owners, both dairy and local, were invited. Following introductions and brief descriptions of each farmers' own enterprise, the group was then asked to list the diseases which they felt were most important to them, and to then list the main problems associated with these diseases. A grid representing the results was drawn on a flip chart, and discussion was then encouraged to enable ranking of the diseases and their reasons of importance. This was done for each square of the grid by comparing it to squares in both the neighbouring row (e.g. how does disease 'a' rank compared to disease 'b' in terms of 'reason 1'?), and the neighbouring column (e.g. how does 'reason 2' rank compared to 'reason 1' for disease 'a'?). When general consensus was reached for each category, the result was written on the flip chart, often in the form of a 'score out of ten', for each square of the grid. An observer recorded the discussion generated by the exercise.

Relevant quantitative information gathered during the exploratory survey was entered into a database (Microsoft Access) and descriptive qualitative results were also recorded.

2.4 Results

2.4.1 Informal discussion

The staple food crop in both Iringa and Tanga regions was maize, which was usually ground into maize flour and then mixed with water and boiled to make a thick maize porridge called 'ugali'. Maize yields varied considerably, with a harvest of approximately 5 bags per acre being obtained from average, non-fertilised land, in contrast to 10 bags per acre from land fertilised by manure, and up to 20 bags per acre if commercial fertiliser, hybrid seeds, and regular weeding were used.

Local cattle were kept by some farmers for milk production, however they stated that production was generally less than one litre per day, with the animal being milked just once daily, and this required the presence of a calf during milking to allow adequate milk letdown.

Many cattle in Iringa were grazed on communal pastures during the day rather than being zero-grazed, and this was particularly true during the dry season when grasses were scarce. In contrast, HIT farmers in the Tanga region risked having their cattle confiscated by TDDP staff if they were caught keeping them under non zero-grazing conditions.

Farmer's perception and knowledge of animal diseases varied considerably, and was largely focussed on TBD, in particular ECF. In addition, although many farmers were aware of certain diseases, their actual knowledge of disease aetiology, pathogenesis, transmission and control was often extremely limited. Although mastitis was not generally volunteered as a major disease problem, a number of farmers were aware of the disease, however, very few had any practical knowledge about it.

Prior to obtaining their HIT animal, all farmers under the TDDP scheme had attended a residential training course at LITI Buhuri which covered the essentials of smallholder dairying under zero-grazing conditions, and for which the farmers had to contribute 8,000 Tsh. In contrast, the majority of HIT farmers in Iringa had not received any formal training, although some had attended a one day course, for which they had contributed 3,000 Tsh, and further follow up and training was then done through monthly EO visits to the farm. On average, one EO in the Tanga rural region would be responsible for 60 to 70 farmers, however it was noted that this figure was likely to be much higher amongst EO in the Tanga urban area.

All cows on smallholder dairy farms in Tanzania were milked by hand, usually twice daily. Cows were usually restrained either by tying by the neck, or by the hind legs. Some farmers introduced a calf to suckle prior to milking to stimulate milk letdown, and this was a particularly common practice if the cow had a high degree of *Bos indicus* in her breeding. A variety of methods of udder preparation were used prior to milking, many of which involved the use of an unwashed, or communal, udder cloths to either wash, or dry, the udder. Application of some form of lubricant to the teats was also common prior to milking, and this ranged from commercial milking salve, or petroleum jelly for human use, to cream, ghee or even milk itself. Generally, no post milking preparations were applied to teats.

Respondents stated that the testing of milk purchased at collection centres, or kiosks, by employees of the collection centres ranged in both the amount, and regularity, of testing undertaken. At most milk collection points basic organoleptic tests were performed, in which the colour, smell and appearance of milk were assessed, and a lactometer was also used to assess the concentration of the milk to determine whether adulteration with either water, or powdered milk, had occurred. Additional tests performed at certain collection points included an alcohol test, in which ethanol and milk were mixed together in order to evaluate the freshness of the milk, and the 'clot on boiling' test that was also used for the same purpose.

Milk was generally transported from the smallholder farm to the collection centre in large plastic buckets with lids, either by young boys on bicycles, or carried by foot on the head of a family member. Many such journeys in peri-urban or rural areas took up to two hours each way. If there was no market for the milk, it was usually returned to the farm and left for one to two days to form 'mtindi', a popular, local form of soured milk, produced by leaving the milk to sour for one to two days to produce a thick soured 'yoghurt-like' substance which is extremely popular for eating with ugali.

The majority of milk was consumed in tea, however fresh milk and 'mtindi' were also commonly consumed. A number of Tanzanians actually found the taste of milk and other dairy products such as cheese and yoghurt undesirable, and if able to afford a drink, preferred instead to purchase a carbonated soda.

Although some respondents commented that the quality of their milk was important to them, these respondents tended to be farmers who sold their milk directly to neighbours, who, in turn, could reject the milk on the basis of quality by simply refusing to buy from that farmer in the future. In contrast, farmers who sold their milk via mass collection centres, where milk from numerous producers was pooled into one large tank, seemed less concerned about the quality of their milk, provided that it passed the tests mentioned previously, and was accepted by the collection centre.

Some respondents were aware of antibiotic milk withdrawal times, but few adhered to them, instead choosing to continue to sell milk from affected animals, or feed it to calves. Milk from a mastitic quarter was generally discarded, or fed to dogs or calves, whilst milk from unaffected quarters was generally consumed as normal.

The main complaint associated with dairying was a steady decrease in milk price over the previous three to four years. Reasons for the falling milk price were thought to include the increased number of producers, and resulting alteration in the balance of supply and demand, particularly during the rainy season when milk supply was plentiful. In addition, the decreased milk prices were felt to be caused by the lack of milk marketing opportunities, which were confounded by the lack of purchasing power of many Tanzanians, and the fact that milk was not a widely appreciated drink, with many Tanzanians preferring to purchase carbonated soft drinks instead.

During a group meeting in one rural village in Iringa, respondents volunteered that they felt that the health of the villagers, and particularly the children had improved since the introduction of dairy cattle to the village four years previously, and the resulting provision of milk as a nutritious foodstuff. The same respondents also felt that the general level of disease in their cattle, both dairy and local, had improved since the formation of a Farmer Group within the village, which had helped to provide education about different aspects of dairy cattle keeping and disease.

Cowboys were often young boys, of between ten and sixteen years of age, who had rarely received a level of education above that of primary school. The cowboys often lived with the farmer's family, and some were given free accommodation and food, but a salary of as little as 10,000 Tsh per month. It was extremely unusual for a cowboy to be paid any form of 'performance related bonus', thus the incentive for maintaining a high standard of cow care was often limited.

It was stated that it was almost impossible for the average Tanzanian to obtain a bank loan, therefore, this was not a practical way to obtain money to purchase a dairy animal. Farmers felt that the banks were simply not interested in lending money to allegedly 'high risk' small enterprises such as their own, and that if they did agree to lend an amount, the level of interest charged by the bank made the loan unaffordable.

Discussions during the exploratory study revealed that a number of villagers had received limited levels of schooling and were illiterate, or only semi-literate. This was said to be particularly common in rural areas, and amongst cowboys and rural women.

During the course of the exploratory study, an evening video screening of a feature film was observed in a rural village, and it was seen that the event had attracted an extremely large audience, the majority of whom appeared to be captivated by the television screen.

It was also noted during the course of the exploratory study that a number of fellow villagers made extensive enquiries about applying for the HIT scheme.

2.4.2 Semi-structured interviews

2.4.2.1 Household and farm details

A total of 52 respondents were interviewed by semi-structured interview in a total of ten villages in both Tanga and Iringa regions. Of these, 42% of respondents were from rural areas, 33% from peri-urban areas, and 25% from urban areas.

Eighty percent of respondents were in a monogamous marriage, whilst 12% were polygamous, 6% were unmarried, and 2% were widowed. The number of inhabitants of a household varied considerably, with the number of adults ranging from one to six, and the number of children ranging from zero to thirteen.

The financial source of the first dairy animal on the farm varied between respondents, with 57% obtaining their animal from an HIT scheme, 4% from an HPI scheme, 12% obtaining a partially subsidised animal, and 27% self financing the purchase of their animal. Seventy three percent of respondents had attended a training course on dairy cattle, and 71% of respondents were members of a Farmer Group.

The total number of cattle present on the smallholder farm at the time of interview varied, with the number of adult cattle ranging from zero to four animals, whilst the number of youngstock ranged from zero to nine animals (Fig 2-1).

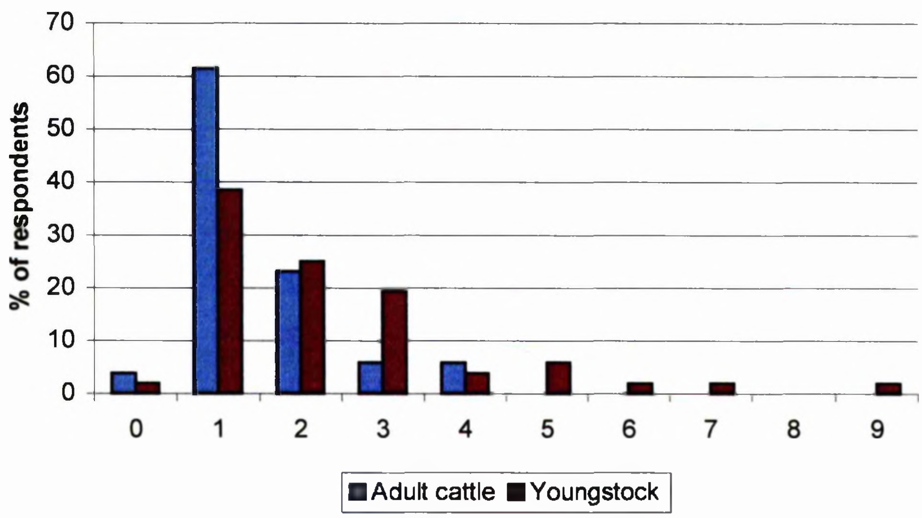


Figure 2-1: Number of adult cattle and youngstock present on respondents' farms (n=52)

2.4.2.2 Milk production and management of dairy cattle

The number of lactating animals present on each farm ranged from zero to four, and the total daily milk production from these animals ranged from 0 to 43 litres per day (Figs 2-2).

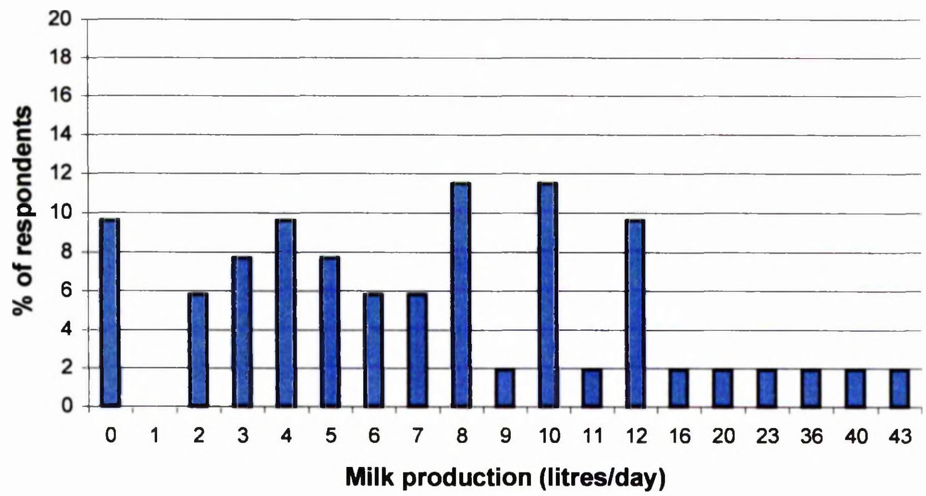


Figure 2-2: Total daily milk production for all lactating cows on respondents' farms (n=52)

A small proportion of respondents (2%) retained milk for home consumption only, whilst the majority of respondents sold milk to a variety of outlets, including neighbours, co-operative dairies, local individuals, hotels, private dairies. and colleagues (Fig 2-3).

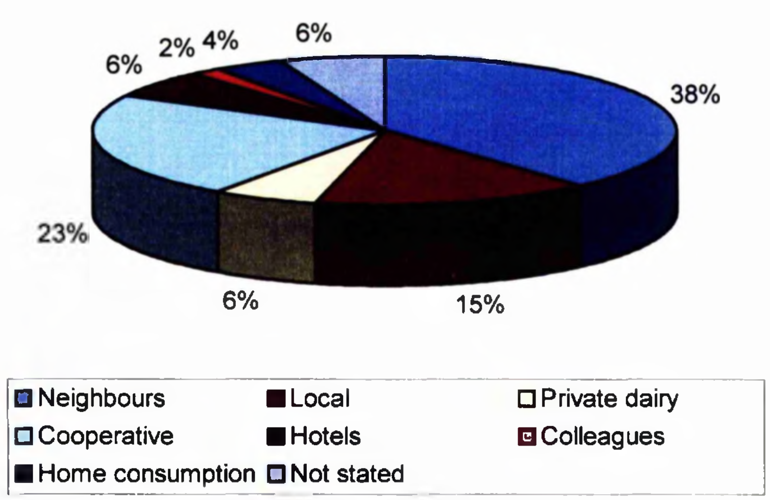


Figure 2-3: Destination of milk from respondents' farms (n=52)

The frequency of cleaning the banda ranged from thrice daily to once weekly, with the length of time spent on this task ranging from less than 15 minutes, to 2 hours (Figs 2-4 and 2-5).

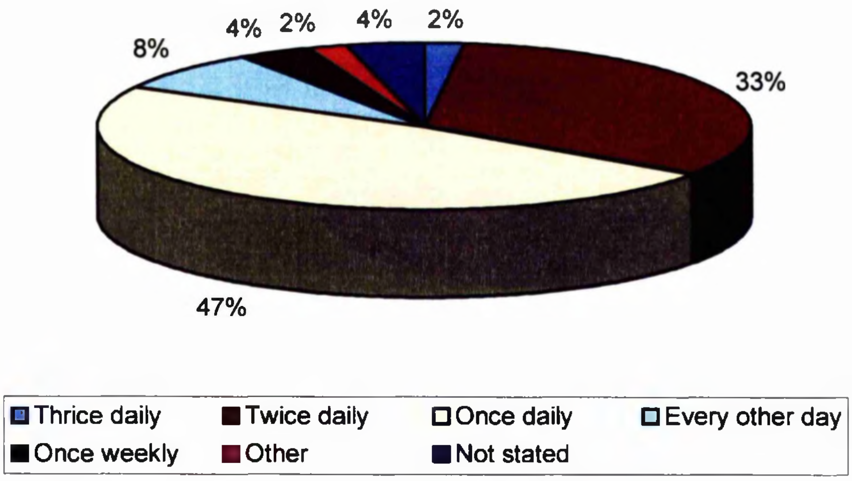


Figure 2-4: Frequency of banda cleaning on respondents' farms (n=52)

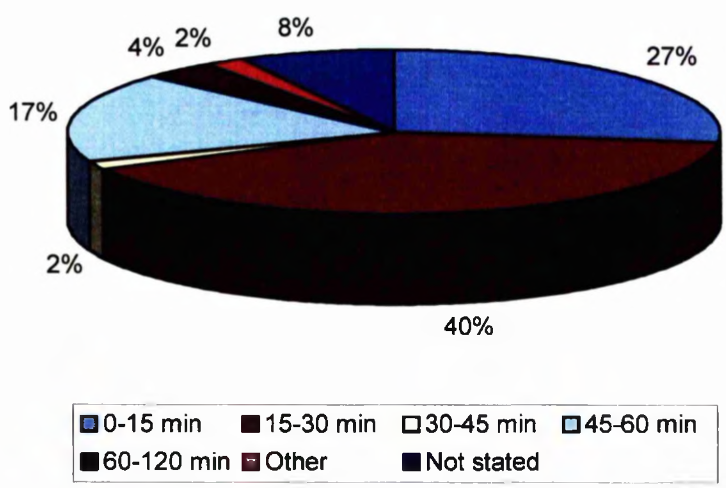


Figure 2-5: Time spent cleaning banda on respondents' farms, per session (n=52)

The amount of concentrate fed to each cow per day ranged from 1kg to over 4kg, whilst other farmers stated that they only fed concentrates according to availability and price. The amount of mineral supplementation ranged from half a matchbox to more than two matchboxes per day, with *ad lib* mineral blocks also being used (data not shown).

Sixty percent of respondents employed a cowboy to assist with the dairy cattle management. The wife was responsible for milking on 29% of farms, the husband on 25%, the cowboy on 25%, a child on 17%, and another individual on 4% of farms (data not shown).

Ninety eight percent of respondents were aware of mastitis, and methods by which respondents had learned about the disease included books, discussion with EO. and experience of a clinical case (Figure 2-6)

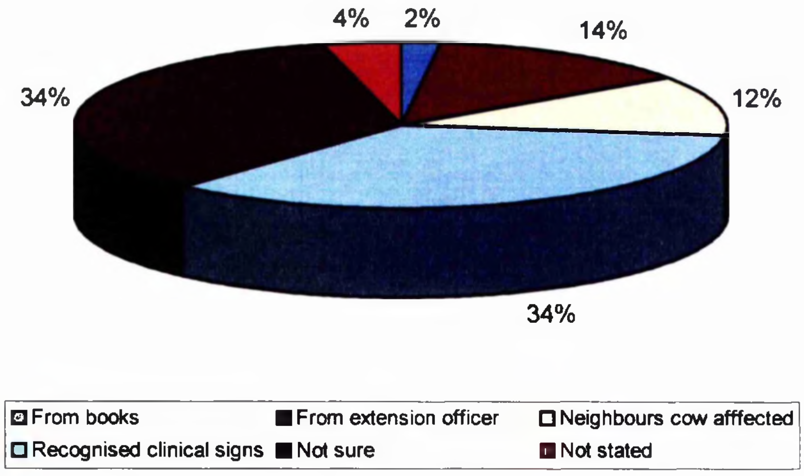


Figure 2-6: Methods of learning about mastitis amongst respondents (n=52)

Fifty six percent of respondents stated that they had seen a clinical case of mastitis in their own cattle. Signs of mastitis recognised by respondents included a painful udder which was recognised by 54% of respondents, a swollen udder by 42% of respondents, clots or flakes in the milk by 29% of respondents, discoloured milk by 25% of respondents, and loss of production by only 6% of respondents (Figure 2-7). Of interest, was the fact that a number of other respondents stated that they had seen clinical signs of mastitis, but had been unaware that these were associated with the disease

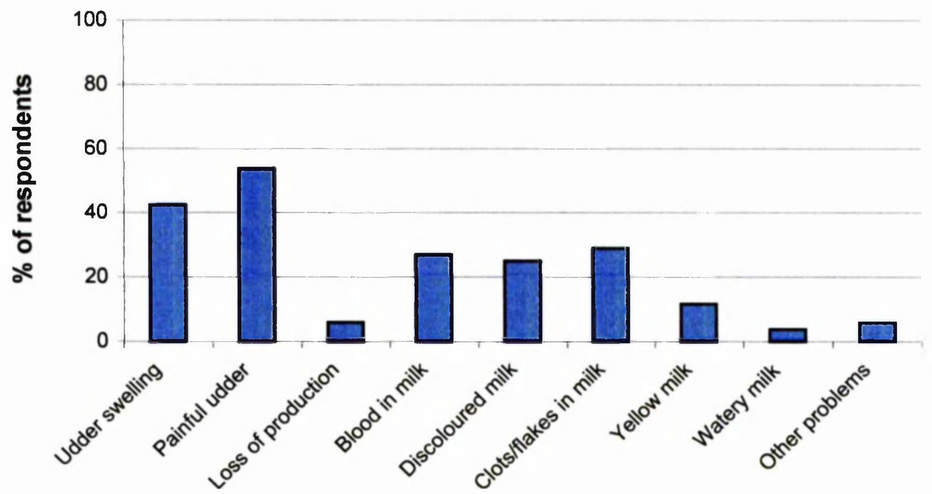


Figure 2-7: Clinical signs of mastitis identified in respondents' cattle (n=52)

Of those respondents who had identified a case of mastitis in their cattle, 91% sought advice from an EO, 3% from a herbalist, 3% from a veterinary surgeon, and 3% from their husband. Ninety three percent of these farmers treated the affected animal, with 53% using intramammary preparations, 34% using injectable antibiotics, 3% using herbal remedies, and 3% using hot water massage (Figure 2-8).

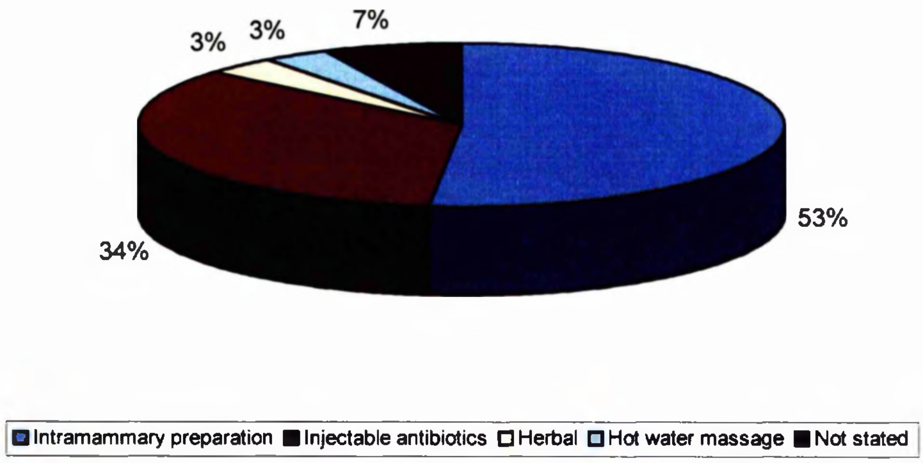


Figure 2-8: Methods used by respondents to treat mastitis in affected animals (n=52)

Amongst respondents who had experienced a case of mastitis in their animals, the two main perceived causes of the disease were incomplete milking (24%) and poor general hygiene (24%), however 41% of respondents were unsure of the causes of mastitis (Figure 2-9).

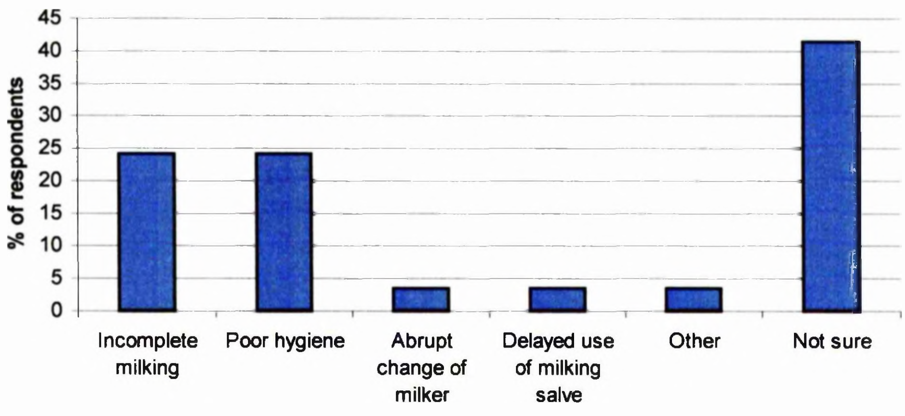


Figure 2-9: Perceived cause of mastitis amongst respondents who identified cases in their animals (n=52)

Fifty nine percent of respondents stated that they had altered their management practices following the identification of mastitis in their animal. Such management changes included improving general hygiene, ensuring complete milking, and residual suckling using a calf (Figure 2-10).

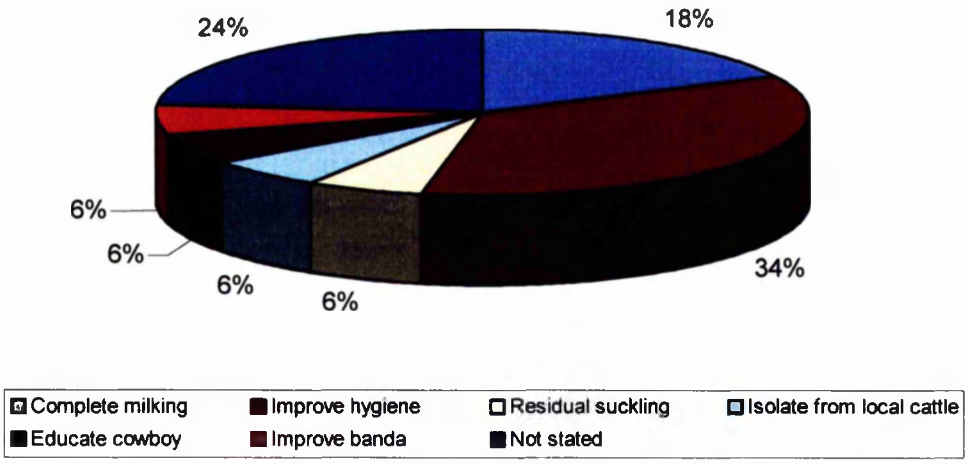


Figure 2-10: Respondents' alterations in management practices following identification of mastitis in their animal (n=52)

Eighty three percent of respondents stated that they had disposed of the milk from all four quarters during the time that their animal suffered from mastitis. However, 7% of respondents stated that they had only disposed of milk from the affected quarter, and a further 3% stated that milk from all quarters had been consumed. Three percent of respondents did not state the destination of milk from the affected cow (data not shown).

Farmers' recollection of the change in yield during a mastitis case ranged from one to eight litres (Figure 2-11), and 17% of respondents stated that the yield was permanently decreased after the case had resolved (data not shown).

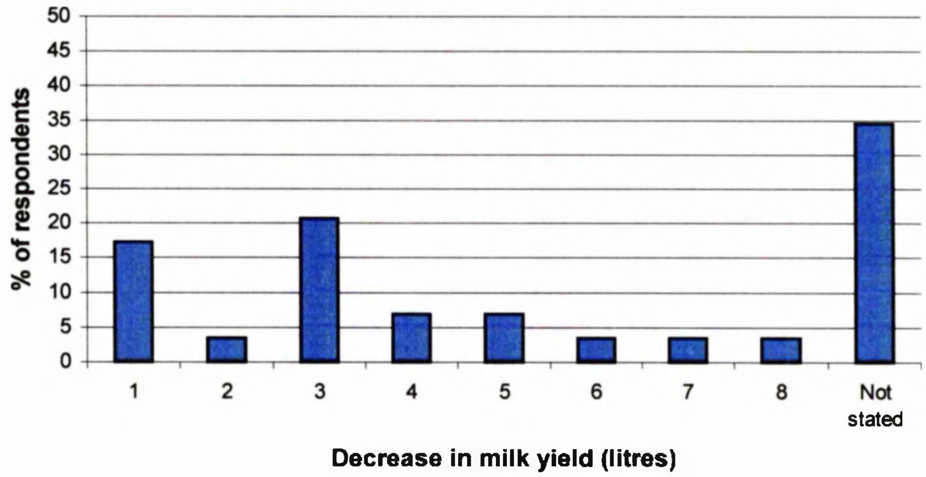


Figure 2-11: Recollected decrease in milk yield experienced in respondents' cows during a case of mastitis (n=52)

The destination of the affected cow following a mastitis case varied considerably, with the majority (66%) of animals being retained on the original farm (Figure 2-12).

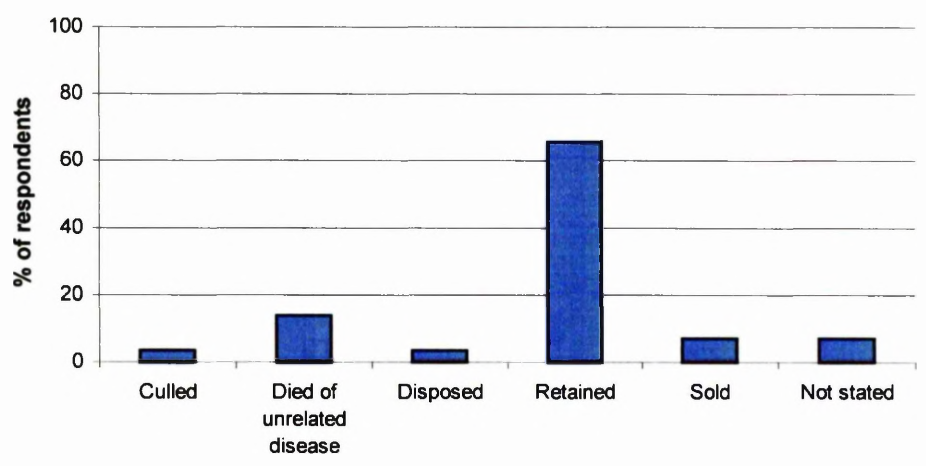


Figure 2-12: Destination of affected cow following case of mastitis (n=52)

When asked about drying off their cattle, 79% of respondents stated that they did so at seven months of gestation, whilst a further 8% dried off at six months of gestation. Reasons for drying off at this time included the fact that the taste of the milk was altered, milk production was at its lowest, the cow would be able to restore her energy reserves, and that respondents had simply been taught to do so (Figure 2-13).

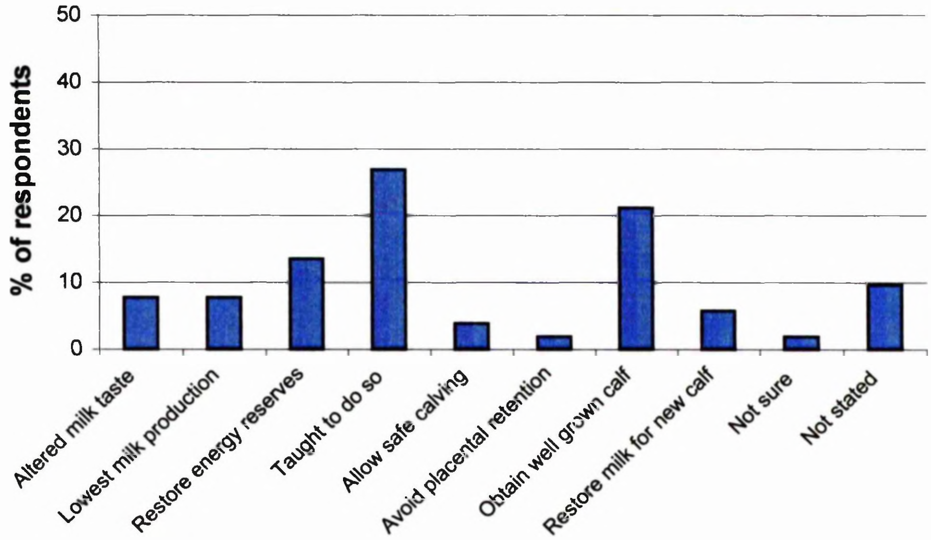


Figure 2-13: Reasons for drying off dairy animals volunteered by respondents (n=52)

2.4.2.3 Sources of household income

The semi-structured questionnaire also yielded information about other farm enterprises and sources of income, and the importance of dairying to the household. Respondents viewed the milk sales from smallholder dairying as a reasonably lucrative income generating activity, in comparison to some other cash crop or business enterprises. One particularly important feature associated with milk sales was the fact that a year round income was generated, rather than, for example, other cash crops which simply provided a lump sum of money at harvest time. In rural areas, 69% of respondents ranked dairying as their most important source of household income, with crop production being ranked second in importance, whilst in urban areas 44% of respondents ranked dairying as their most important source of income, with off-farm employment being ranked second in importance.

Other important cash crops and sources of household income varied between study areas according to land type, land area available, and access to main roads linking towns with main markets in Dar-es-Salaam. Cash crops in these areas included banana, coconuts, sugar cane, local brew, layer hens, and pig rearing. Benefit-cost ratio (BCR) calculations for these crops in comparison to dairying were calculated by a project colleague **(Leslie REF).** These results are summarised in Table 2-1, and show that smallholder dairying for an HIT farmer showed a BCR of 1.1 in Tanga and 1.3 in Iringa, whilst coconuts in Tanga had a BCR of 4.3, and pork production in Iringa had a BCR of 12.0. Other important crops and enterprises mentioned by respondents, but for which BCR were not calculated, included banana, cloves, tomatoes, and fishponds.

Crop / enterprise	Study area	Benefit Cost Ratio	Comments
Smallholder dairying with HIT cow	Tanga Urban	1.1	If labour paid
Smallholder dairying with HIT cow	Iringa Urban	1.3	Cheaper labour and feed costs than Tanga
Milling	Tanga Urban	1.8	
Coconut	Tanga	4.3	
Sugar cane	Tanga	4.8	(B/C ratio of 21 if cane brewed into 'puya' local brew on farm)
Layer hens	Iringa	8.7	
Pigs (pork production)	Iringa	12.0	

Table 2-1: Benefit-cost ratios for different enterprises within Iringa and Tanga regions (Leslie et al, 1999).

Off-farm employment generated a wide range of salaries, quoted as being between 33,000 Tsh per month (the official minimum Tanzanian wage) and approximately 200,000 Tsh per month for a professional or senior Government official. Informal discussion concerning this topic revealed, however, that the official minimum wage is often ignored, and certain jobs such as a 'housegirl' or 'cowboy' provided salaries as low as 10,000 Tsh per month. In addition, certain employers failed to pay their employees on a regular monthly basis, thereby causing the monthly household income to fluctuate widely.

2.4.2.4 Benefits and costs associated with dairying

The exploratory study identified that the average costs associated with a HIT dairy enterprise included 137,500 Tsh for construction of the banda, 250,000 Tsh for cash repayment of the heifer loan (unless the loan was repaid by returning a pregnant heifer to the project), labour costs of 156,000 Tsh per year if an attendant was employed, veterinary input costs (including acaricide) of 43,379 Tsh per year, and bull service charges of 5025 Tsh per year (Leslie et al., 1999). Calculations by a project colleague showed that from year four of the HIT dairying enterprise onwards, the average profit generated per year would be 122,660 Tsh (Leslie et al., 1999).

The profits from dairying were spent in a variety of ways, with 67% of respondents using them for daily household and other cash needs, whilst 24% used them for payment of school fees, 24% to meet livestock input costs, 12% on other agricultural activity, and 17% invested the money into savings or the purchase of another cow (the responses were not mutually exclusive).

One fact mentioned commonly by dairy farmers and their families was that ownership of dairy cattle was an important form of 'insurance', as animals, usually youngstock, could be sold in order to raise capital in an emergency. Of 30 respondents, 37% had used money from such sales to pay for emergency hospital treatment, and 13% for the payment of school fees, which at the time of the study were 4000 Tsh per year for primary school education. This form of 'insurance' was felt to be particularly important for widows or other female-headed households, who often had few other means of rapid income generation at their disposal. In addition to emergency situations, a number of smallholder farmers mentioned that profits from dairying had allowed them to improve their family's standard of living, for example by purchasing additional land for their shamba (the agricultural plot on which crops are grown), or corrugated iron sheets to roof their house, or a bicycle for transportation. Some farmers had also used dairying profits to purchase further dairy animals, or to improve the construction of their banda.

Some respondents employed labour on only a part time basis, particularly around planting, weeding, and harvesting times on their shambas. However, 58% of respondents employed full time labour, and of these, 90% stated that this was solely for attending their cattle. In many rural villages the responsibility of cattle care rested solely with the family, however, in urban and peri-urban areas many smallholder farmers employed an attendant to assist with the daily care of the cattle. The duties of such attendants included some, or all, of the following: cleaning the banda, collecting fodder, milking the cows, transporting the milk to a point of sale, and administration of acaricide to the cows. In some cases, family members were also responsible for some of these activities, however overall supervision of dairy activities usually fell to a senior family member, often the wife of the household.

2.4.2.5 Constraints

When asked about the main constraints faced on their farm, 69% of respondents volunteered livestock related problems, and 31% volunteered crop related problems. Livestock related problems included poor prices for livestock products, particularly milk, poor milk marketing or collection services, distance from milk markets, problems with monthly milk payments, high feed costs, and feed availability. Crop related problems included high costs and poor availability of agricultural inputs such as seeds and fertilisers, cost of labour, and lack of capital. Twelve percent of respondents volunteered animal disease, and 6% volunteered the cost of animal drugs, as the most important constraint.

Farmers' perceptions and knowledge of animal diseases varied considerably, and was largely focussed on TBD, in particular ECF. In addition, although many farmers were aware of certain diseases, their actual knowledge of disease aetiology, pathogenesis, transmission and control was often extremely limited. Although mastitis was not generally volunteered as a major disease problem, a number of farmers were aware of the disease, but very few had any practical knowledge about it.

During semi-structured interviews farmers were asked to rank cattle diseases in order of importance, however, it was found that this exercise proved to be extremely difficult on an individual basis, as farmers were unfamiliar with the concept of ranking, and the exercise was therefore discontinued.

2.4.3 Extension Officer Interviews

Within the two study areas, twelve EO assisting with the project were interviewed to obtain their perceptions about smallholder dairy farming, and associated constraints and disease problems.

In rural areas a major constraint was seen to be the lack of input supplies, particularly veterinary drugs, minerals, fertilisers and seeds, coupled with farmers' lack of purchasing power for such inputs. In urban and peri-urban areas the main constraint was thought to be lack of access to good quality grazing or fodder during the dry season, resulting in poor nutrition and poor milk yields. Disease was also considered to be a major constraint, whilst other constraints mentioned included poor soil fertility, poor village infrastructure, crop marketing problems, time required for collection of water and firewood, EO transportation difficulties, and inadequate numbers of EO. Constraints relevant to milk production included the fluctuation in milk price, particularly between the rainy and dry season, transportation to milk collection centres, and lack of reliability of one particular milk purchaser.

Commonly recommended veterinary practices included administration of anthelmintic to all ages of cattle at intervals of three months. In addition EO recommended regular acaricide application, vaccination against ECF, CBPP and FMD, and regular preventive therapy against trypanosomosis in areas of high tsetse challenge.

The most common disease volunteered by EO in all areas was ECF, and it was also ranked most highly in importance. Other commonly encountered diseases included anaplasmosis and helminthosis, whilst trypanosomosis, babesiosis, mineral deficiencies, mastitis, blackquarter, FMD, heartwater, traumatic pericarditis, plant poisoning, snakebite and dystocia were also reported.

A brief survey of veterinary input shops was also carried out during the exploratory survey, which revealed a number of interesting facts. Main veterinary input shops were generally only found in the largest towns, such as Iringa, Tanga and Korogwe, although small kiosks with a limited range of products were found in some smaller areas. Farmers generally only administered acaricide to their animals, and most other treatments were given by the EO, although farmers were sometimes sent by the EO to purchase drugs. Input shops were either privately owned, or acted as 'agents' for particular pharmaceutical companies, and a veterinary surgeon was often not constantly present to give advice on appropriate purchases. Credit facilities were not available to farmers and all accounts were settled at the time of purchase. Many shops stocked only a limited range of pack sizes, and often would not 'split a pack' in order to supply 'single doses'. Smallholder farmers generally purchased the smallest pack size available, however, some shops were prepared to decant a smaller volume of a drug into a separate container, although these were rarely accompanied by any user instructions. Many drugs had instructions written only in English, with only a few products, generally those repackaged in Kenya, having Kiswahili instructions. Although most classes of drug were constantly available at any one time, one particular preferred brand of drug was often unavailable consistently throughout the year, thus requiring purchasers to familiarise themselves with new products and their associated user instructions. Details of products, costs, and package sizes of drugs available in veterinary and agricultural input shops in Iringa and Tanga were obtained, and are included in Appendix 1.

2.4.4 Wealth ranking

Five different wealth groups were identified, and defined conditions and abilities for each group are summarised by village in Table 2-2. Factors considered during the wealth ranking exercise included the number, and type, of livestock owned, with dairy cattle being regarded more highly than local cattle, and in one village the daily milk production of the dairy cattle was also taken into account. Other important factors included the amount, type, and fertility of land available to the household, and whether this was owned, rented or borrowed. The type of crop grown on the land, whether cash or subsistence, was also important, as was the yield obtained per acre. The house itself was considered an important indicator of wealth and ability, with cement or brick built houses with an iron roof being more highly regarded than those constructed of mud and poles with a thatched roof. The level of education of the householder was also considered to have an important influence on the wealth and ability of the household, whilst the ability of the household to pay for education, particularly secondary education, for their children was also considered to be important. Similarly, the ability of a household to pay for healthcare and medicines was also considered important, as was the actual health of the head of the household. Ownership of a business such as a milling mill, or involvement with another enterprise such as fish farming, was seen as a major indicator of wealth, whilst ownership of a smaller enterprise such as a village kiosk tended to apply to farmers in the middle wealth groups. Single mothers tended to be ranked in the lower wealth groups, however, interestingly, single mothers who owned dairy cattle were ranked higher than single men or women who did not own such animals. Ownership of material goods, such as bicycles or radios, was also considered to be an indicator of wealth, whilst the need to seek casual employment was seen as an indicator of poverty.

Results of the exercise showed that in Boza and Shebomeza villages the majority of dairy farmers were ranked into wealth groups two and three by fellow villagers (with group one being the wealthiest, and group five the poorest), with a small proportion also falling into groups one and four. In Lulanzi village, however, the vast majority of dairy farmers were ranked in wealth group one, with the remaining two farmers being ranked in wealth group three.

Wealth Rank	*Boza village* **Conditions/abilities**	*Shebomeza village* **Conditions/abilities**	*Lulanzi village* **Conditions/abilities**
1 **(most wealthy)**	>15 cows 10 local cattle Cash crop: >5 acres Maize: > 5 acres Brick house Iron roof Business (mill or shop) Motor bike or car *⇒ 10% of households in village* *⇒ 7% of dairy farms in village*	3-4 dairy cattle & followers 16 litres milk yield/day/cow Cane harvest: 6-10 acres Cement/brick house Iron roof Business (mill, shop or fishpond) High level of education for children *⇒ 2% of households in village* *⇒ 4% of dairy farms in village*	3 dairy cattle & followers 5 local cattle Shamba: 8 acres 64 bags food / year Use fertiliser Cement/brick house Iron roof
2	2-3 cows 5 local cattle Goats Cash crop: 4 acres (citrus or coconut) Maize and banana Brick house Thatch roof Primary school and hospital costs met Small business (eg. fish sales or 'local brew' beer) *⇒ 13% of households in village* *⇒15% of dairy farms in village*	2 dairy cows & followers 3–5 acres cane or banana Shamba: 5-6 acres Mud house Iron roof Primary school and hospital costs met Sale of 'local brew' beer *⇒ 8% of households in village* *⇒14% of dairy farms in village*	1-3 dairy cows 2 local cattle 3-4 goats Shamba: 5 acres 18 bags food / year Iron roof Primary school costs met
3	≤ 1 dairy cow & followers Goats Chickens 2-3 acres subsistence crops (maize or cassava) Hens and goats Small business (eg. coconut sales, small shop, small bar) Primary school and hospital costs met Bicycle *⇒ 29% of households in village* *⇒ 70% of dairy farms in village*	1 dairy cow 5 litres milk yield/day/cow 2 local cattle 2-3 goats Shamba: 2-3 acres subsistence crops only (maize or cassava) Mud house Thatch roof Kiosk Primary school and hospital costs met Bicycle *⇒ 54% of households in village* *⇒ 77% of dairy farms in village*	2 local cattle (poorly managed) Pigs, goats and sheep Shamba: 1-2 acres 4-8 bags food / year Dirt floor to house Iron roof

4	1-2 Local cattle Hens 0.5-1 acre subsistence crops (maize or cassava) <20 trees, low production Mud house without poles Thatch roof Unable to meet primary school and hospital costs *⇒ 26% of households in village*	No livestock Shamba: borrowed ~1 acre Mud house with poles Thatch roof Primary school and hospital costs met *⇒ 35% of households in village* *⇒ 4% of dairy farms*	No livestock Chickens, guinea pigs and rabbits (for meat) Shamba: 2 acres 5 bags food / year Thatch roof Bicycle Polygamist (compared to wealth rank 5)
5 **(least wealthy)**	No developed land Not sufficient in food Poor mud house Thatch roof Dependent on relatives May have a disability Unable to meet primary school and hospital costs *⇒ 21% of households in village*	No developed land No house Casual employment as labourer (accommodation provided) No family Unable to marry Dependent on relatives Unable to meet primary school and hospital costs *⇒ ≤1% of households in village*	No livestock Shamba: ≤ 1 acre ≤ 2 bags food / year Small mud hut Thatch roof Casual employment as labourer Unable to meet primary school and hospital costs High mortality > 5 children
Comments	1% of households not clearly classified 8% of dairy households not clearly classified	1% of dairy households not clearly classified	Proportion of households falling under each category not accurately recorded due to technical difficulties All cattle owners in village were ranked in wealth group 1, except for two farmers who were ranked in wealth group 3

Table 2-2: Summary of wealth ranking exercises in three villages, Boza, Shebomeza and Lulanzi. The conditions volunteered by respondents for defining each wealth group are shown, along with the proportion of total villagers, and proportion of dairy farmers failing into each category.

One extension officer felt that farmers in wealth ranks one and two differed considerably according to how hard they worked. Factors of importance included the amount of crop harvested from each acre of land, the quantity and quality of pasture fed to their cattle, and the farmer's eagerness to learn about new subjects. The EO felt that these facts were, in turn, related to the farmer's level of education and understanding of farm practices.

2.4.5 Matrix ranking

Results of the matrix ranking exercise are summarised in Table 2-3. At the start of the exercise in Madanga village the eight respondents volunteered trypanosomosis, parasitic otitis, mastitis, ECF, helminthosis, and diarrhoea (not in rank order) as the major disease problems for their cattle. Reasons for volunteering these conditions included the associated mortality, morbidity, production losses (growth, body condition, milk production, and reproductive performance) and treatment costs.

Although none of the respondents' cattle had suffered from the disease, ECF was ranked as the most important condition overall. Respondents were aware of eight cattle from their village that had died of the disease, and they associated the disease with high levels of mortality and morbidity, adverse effects on performance, and high cost of treatment. It was believed that the chance of recovery from ECF was guarded, even when treatment was obtained. The cost of treatment of ECF was also considered to be a major constraint, costing up to 40,000 Tsh in some cases, and could necessitate the sale of a calf to cover the capital outlay required. Other important factors associated with ECF included decreased milk yield, and decreased reproductive performance.

Trypanosomosis was felt to be a problem because of the associated emaciation and loss of milk yield seen in affected cattle. Reproduction was also affected, in the form of abortion and lack of oestrus signs. The disease also required repeated treatments, leading to significant expense. Respondents were also aware that trypanosomosis was transmitted by the tsetse fly, whose habitat and breeding sites were local bushes, and that the use of 'pour-on' preparations helped to prevent the disease.

Mastitis was volunteered as an important disease due to the associated loss in milk yield, which could ultimately lead to permanent functional loss of the quarter. The principal signs of mastitis which respondents volunteered were clots or flakes in the milk, and a painful udder. Within Madanga, mastitis had only been treated using the local method of massaging the udder with warm water, followed by the application of coconut oil.

Parasitic otitis had been experienced in the cattle of two respondents in the group, who volunteered that the principal signs associated with the disease were head pressing, restlessness during milking, and a foetid smell, however they emphasised that the disease did not result in death of the cattle. Helminthosis was associated with a decreased milk yield in lactating animals, and stunting or loss of condition in youngstock. A pot-bellied appearance, and diarrhoea were also mentioned as features of the disease, however respondents felt that it was relatively cheap to control. Diarrhoea was considered to be a problem mainly amongst youngstock, which lead to stunting, or loss of condition.

Results of the matrix ranking exercise in Lulanzi village were very similar to those of Madanga, however, additional diseases and their associated problems which were volunteered included footrot in cattle, which caused lameness and swelling of the foot; FMD, which caused ulceration of the mouth and resulted in difficulty grazing; coughing in adult cattle; lacrimation and blindness.

The decrease in milk production attributable to each disease (Table 2-3) was an estimated value reached following consultation between respondents. The overall rank given to each disease was based on a consensus reached by respondents at the end of the exercise, following consideration of the overall matrix, rather than a total summation of the scores in each column of the matrix.

Overall ranking of the diseases created considerable discussion amongst respondents, particularly concerning the ranking of ECF and trypanosomosis. Finally, respondents agreed that ECF should be ranked as the most important disease above trypanosomosis, as they felt uncertain about the signs of ECF, the onset of disease meant that there was little time to seek EO advice, and the capital outlay for treatment was prohibitive. In contrast, respondents felt fully aware of the clinical signs and methods of treatment of trypanosomosis, and felt that the onset of disease allowed adequate time to seek assistance from the EO.

Disease ***(Local name)***	**ECF** ***(Ndiganakali)***	**Trypano-somosis** ***(Ndorobo)***	**Helminth-osis** ***(Minyoo)***	**Mastitis** ***(Kiwele)***	**Diarrhoea** ***(Kuharisha)***	**Parasitic otitis** ***(Sikio)***
Group experience (n=7)	0/7	7/7	3/7	2/7	2/7	2/7
Mortality (score)	10/10	1/10	2/10	0/10	0/10	0/10
Morbidity (score)	10/10 (no preventive treatment used) 3/10 (preventive treatment used)	10/10 (no preventive treatment used) 1/10 (preventive treatment used)	10/10	5/10 (properly milked) 10/10 (improperly milked)	0/10	0/10
Stunting or loss of condition (score)	2/10	7/10	7/10	Not affected	7/10	Not affected
Decrease in milk production (volume)	10 l (10 l→0 l) (cow dies)	7 l (10 l→3 l)	2 l (10 l→8 l)	5 l (10 l→5 l) (depends on no. of teats affected)	1 l (10 l→9 l)	2 l (10 l→8 l)
Reproductive performance (subjective)	May be affected	Affected	Not affected	Not affected	Not affected	Not affected
Abortion (yes/no)	Yes	Yes	No	No	No	No
Treatment costs (subjective)	High (up to 60,000 Tsh per case)	Moderate (1600 Tsh per month)	Moderate	Few (local tx: warm water & coconut oil)	Few	Few
Overall rank *(consensus)*	**1**	**2**	**3**	**4**	**5**	**6**

Table 2-3: Results of matrix ranking exercise in Madanga village. The aim of the exercise was to obtain farmer perceptions about important animal diseases, and involved a group discussion with eight respondents from the village. Scores are illustrated as a 'mark out of ten' to represent the relative levels of importance.

2.5 Discussion

Results of the exploratory study suggested that illiteracy was a problem, particularly amongst cowboys and rural women, who were often closely associated with the daily care of cattle on smallholder dairy farms, and suggested that pictorial methods of dissemination such as diagrammatic posters or pamphlets, or multimedia based methods such as video, television and radio, would be desirable. In addition, observation of the evening video screening in one rural village identified video as an extremely popular multimedia method that was able to target large groups of individuals at one time. One of the major findings of the exploratory study, therefore, was the author's identification of methods that might be appropriate for future mastitis knowledge dissemination exercises (see Chapter 3). Results of the exploratory study also enabled the author to gain an insight into smallholder farming in Tanzania, including common practices carried out on smallholder dairy farms, and the role and importance of dairying within smallholder households.

In general, disease knowledge amongst respondents was poor, which may have been attributable to the fact that many farmers were from tribes with no history of cattle keeping, who may also have had little family or personal experience of livestock keeping. In addition, many farmers in Iringa received only an extremely limited training prior to receiving their HIT or TWIT cow, in contrast to those in Tanga who had attended the LITI Buhuri training course. It was noted that many farmers were only aware of a limited number of diseases, most of which tended to be TBD. This was perhaps understandable, as these diseases received the most attention from EO, who, in turn, had the main responsibility for educating farmers about such matters. Matrix ranking and EO interviews revealed that ECF was considered to be the most important disease by both farmers and EO, however, it should be noted that matrix ranking exercises were undertaken in villages which had previously suffered from TBD problems. Matrix ranking with a group of respondents was, however, found to be an effective method of establishing farmer perceptions about certain diseases, and disease control within a specified village, however, care should be taken not to extrapolate these findings to other areas. It was also found that, after lengthy group discussion, respondents were able to rank the different diseases, in contrast to ranking of disease by individual respondents which was found to be much harder, and was in fact abandoned.

Results of the wealth ranking exercise in Shebomeza and Madanga showed that the majority of dairy farmers were ranked in the medium wealth group, whilst remaining dairy farmers were ranked in the most wealthy (1) and second wealthiest (2) groups. In Lulanzi, the vast majority of dairy farmers were ranked in the most wealthy group (1), with the remaining two farmers being ranked in the medium wealth group (3). This difference perhaps reflects the fact that most animals in Lulanzi were obtained by private purchase following the disbandment of the 'Ujamaa' co-operative village system in the early 1990's. This resulted in the village herd being sold off for cash to private farmers, whilst in contrast, a number of villagers in Boza and Shebomeza had obtained their animals via HIT or TWIT schemes.

It should be acknowledged that both the matrix ranking and wealth ranking exercises were only undertaken in rural villages during this study, and it is suggested that these exercises may be hard to undertake in urban or peri-urban areas where respondents are less familiar with their neighbours and fellow villagers than those in rural villages.

The general discussion throughout the exploratory study revealed that smallholder dairying was considered to be a good source of income, however, the main associated complaint with the enterprise was a steady decrease in milk price over the previous three to four years. The BCR calculations from the exploratory study showed that smallholder dairying under an HIT scheme actually yielded a considerably poorer return in comparison to other enterprises such as pig rearing or layer hens. It can be speculated however, that the initial capital outlay for such ventures may be higher than that of smallholder dairying, as both accommodation and livestock must be purchased, whilst an HIT farmer needs only to invest in building a banda and, in Tanga, attending a training course, as the animal is supplied on a credit basis.

It was recognised that responses given by respondents during the exploratory study might have been biased towards smallholder dairying, as respondents were made aware of the overall purpose of the project during team introductions. It may, therefore, be assumed that responses were particularly focussed on dairying, rather than the overall activities of a smallholder farmer. For the same reason, it was sometimes felt that respondents were perhaps 'giving the answers they thought that we wanted to hear', particularly focussing on problems and constraints associated with smallholder dairy farming. Another factor possibly influencing this phenomenon was the fact that farmers were being visited for the first time by the project team, and had not therefore had time to build up a rapport with the team, or feel sufficiently comfortable to volunteer honest answers. One farmer was unwilling to volunteer how many cattle he owned, as he was worried that the project might have had links with the Ministry of Water and Livestock Development who could then use the information to impose 'ownership of cattle' taxes on him. It was also recognised that some respondents, particularly women or young cowboys, were sometimes shy, and appeared intimidated talking to a large group of people, or talking to male individuals, particularly if their husband or employer was present. Wherever possible this was addressed by one sensitive female interviewer taking the respondent to a private location and interviewing them on a one-to-one basis. Also of note was the fact that the head of household, who often had extremely limited knowledge of the dairy enterprise, often insisted on being interviewed, rather than the person involved with the daily care of the cattle. This was felt to be due to cultural issues in which the head of the household is always the first point of contact, and represents the whole family. For this reason, responses obtained may not always have been a true representation of cattle ownership details.

3 METHODS OF KNOWLEDGE DISSEMINATION

3.1 Introduction

In the field of knowledge dissemination, little is known about which methods are effective in changing knowledge or behaviour or, indeed, why certain methods are effective (Oakley, 1995, cited by Mitchell et al., 2001). Measures which are considered to be important when selecting dissemination methods for a study include, reach and accessibility, acceptability, understanding of the message, and message retention. Reach and accessibility refers to the extent to which the method reaches the target population, whilst acceptability refers to how the community rates the method. Understanding of the message refers to whether the intended message is received clearly and understood by all members of the community, and message retention refers to the length of time for which the community remembers the message (Paton, 1987 cited by Mitchell et al., 2001).

Bessoff (1995) stated that 'to adequately educate people, instructors must recognise how people learn', and suggests that three learning modalities exist: verbal, visual and kinaesthetic, one of which is usually the dominant modality, and used most frequently by an individual student. Verbal education occurs mainly through lecturing to an individual or group, whilst visual methods use any readable or observable materials, and kinaesthetic learning involves the ability to see, hear, touch and incorporate other senses as an active part of the education process (Bessoff, 1995).

'Cultural competency' has been defined as a measure of a successful dissemination programme, and refers to the extent to which dissemination messages have been tailored to the target audience (Clarke, 1995, cited by Mitchell et al., 2001). In addition to the type of dissemination method used, it is also considered to be important to allow time for questions to be asked following dissemination, as this process can increase the likelihood that messages are understood (Mitchell et al., 2001). Messages presented in several different formats can enhance learning (Mitchell et al., 2001), and in a multiple method approach the methods may work synergistically to reinforce messages, and overcome weaknesses inherent in individual methods (Mitchell et al., 2001). The level of literacy, and general reading culture of the target audience are also important considerations if text based methods of dissemination, such as pamphlets or booklets, are to be used (Mitchell et al., 2001).

Visual literacy is a term relating to the ability of an individual to accurately understand and interpret an image presented to them (Linney, 1995), for example whether a 2D diagram of a cow is actually interpreted as a cow by the respondent. If common pictorial conventions are not understood, an image may simply appear as a collection of lines, shapes, tones and colours on a flat piece of paper (Linney, 1995). Common difficulties associated with visual literacy include a failure to understand perspective, or pictorial conventions relating to scale, size, movement, and sequences of pictures (Linney, 1995; Byram and Garforth, 1980).

The phenomenon of visual literacy has particular relevance for those who have not been exposed to a variety of 2D images, perhaps due to a lack of schooling, or because of residing in a remote rural village with few resources (Byram and Garforth, 1980). There is a severe shortage of educational pictures in most developing countries, and in addition, many school classroom walls are bare (Linney, 1995). The resulting consequence for children in such countries, is that school education provides them with little information from pictures, and this is then further compounded during their adult lives (Linney, 1995). If people from poor communities receive little exposure to pictures, their opportunities to learn how to understand and interpret them are extremely limited. This is in contrast to people from more affluent communities in developed countries, where exposure to pictures is common, and visual literacy skills are developed during school education and beyond (Linney, 1995).

It has been shown that many people are not visually literate, and are therefore unfamiliar with interpreting pictures, particularly in countries with low levels of literacy (Linney, 1995; Harford and Baird, 1997), and this has lead to the widespread failure of many visual communications activities (Linney, 1995). Most difficulties, however, result from a failure to understand a small number of pictorial conventions, which many people would probably learn to understand within a few hours (Linney, 1995). In addition, it was recognised by one study that short periods spent explaining a picture helped to improve the visual literacy of a respondent, and that their understanding of images increased according to the number of images to which they were exposed (McBean, 1989, cited by Linney, 1995). Linney (1995), therefore, suggests that the use of an image, which may not be immediately understood by a respondent, is acceptable provided that the image is explained, and that by doing so, the visual literacy skills of the respondent are actually improved (Linney, 1995). The same author also states that 'It is widely accepted that literacy training is an essential part of education for development. Should we not attach an analogous importance to training for improving visual literacy?'.

In the field of mastitis education, Bessoff (1995) suggested that future educational requirements include the need to present all levels of mastitis education to a global audience in the appropriate language, using presentation aids and styles consistent with the audience's cultural background. In addition, it is suggested that the presenter will need to be perceptive in order to adapt the education to the needs and skills of the students, and that easily understandable support material will also need to be produced and dispensed, which may necessitate the need for more visual aids such as posters or videotapes for students with limited literacy, particularly in developing countries.

3.2 Visual aids as dissemination methods

It has been recognised by a variety of professionals, including school teachers, teacher trainers and development workers, that visual aids are effective in helping people to learn and remember information, and that in addition, they may enable non-literate people to analyse, express and record their choices (Harford and Baird, 1997). It has been recommended that it is advantageous to select and produce visual aids specifically for an individual project, as this enables selection of the most appropriate types of visual aid according to resources, budget, and purpose of the project, and results in production of visual aids which are directly relevant and appropriate to the target audience (Harford and Baird, 1997).

Selection of a visual aid should include consideration of whether members of the target audience have had any formal education, and more importantly whether they are visually literate. Other factors which should be considered when developing visual aids, include the language in which text should be written; whether certain colours have special significance to the target audience; whether social, cultural or religious beliefs and practices should be taken in to account; the diversity of the target audience in terms of age, gender, class and caste; and the methods by which the target audience usually obtain information and communicate (Harford and Baird, 1997). It is also important that members of the target audience are able to relate to the issues depicted by the visual aid, and feel that the issue is relevant to their lives, so it is therefore recommended that local situations are depicted, using images from the own lives of members of the target audience where possible (Harford and Baird, 1997).

Research into visual literacy has identified a number of specific problems which should be considered when developing visual aids which include: difficulty in understanding a sequence of pictures; confusion caused by the inclusion of unnecessary background detail; failure to understand the representation of depth or perspective in pictures; improved recognition of pictures based on what is familiar locally e.g. local clothes, houses, utensils with which the target audience are familiar (Byram and Garforth, 1980; Harford and Baird, 1997; Holmes, 1963, cited by Linney, 1995). In addition, many languages are read from right to left, and this may therefore influence the order in which a series of images will be read by the target audience (Harford and Baird, 1997, Linney, 1995); a series of images may not be assumed to be connected; symbols such as crosses, arrows and ticks are culturally specific and may not therefore be recognised by the target audience (Harford and Baird, 1997; Unicef, 1976, cited by Linney, 1995); speech bubble conventions used in cartoons may not be understood (Harford and Baird, 1997); images of humans are more easily recognised than those of animals, plants or inanimate objects; picture content affects understanding to a greater degree than art style, but detailed shaded line drawings are the most easily understood art style (Cook, 1981, cited by Linney, 1995).

Other recommendations when producing visual aids include maintaining consistency of a character from picture to picture, using concise and clearly illustrated text, and laminating materials to provide protection and durability (Harford and Baird, 1997). It is recommended that posters are most effective when they have clear, uncomplicated pictures, and short written messages. Transparencies for use with overhead projectors should include a maximum of six to seven points, and text should be at least 1cm high. Pamphlets should be clearly and simply written so that they are clearly understood, and contain as many pictures as possible (Harford and Baird, 1997).

Daborn et al (1999) found during their study involving the training of CAHW in pastoralist communities of Tanzania, that it was important to use local disease terminology, often based on clinical signs rather than aetiology of the disease, when disseminating extension messages, developing training manuals or designing control strategies (Daborn et al., 1999).

Byram (1980) suggested that interpretation of dissemination materials can occur on at least three levels, including recognition of individual symbols, understanding the relationships between the symbols in portraying an activity or scene, and interpreting the message that is conveyed by the symbols (Byram and Garforth, 1980).

It is, therefore, important than any visual aids intended for use as dissemination materials are pre-tested with appropriate representatives of the target audience before use, in order to establish that the images are relevant, easily understood and interpreted, and convey the intended information. If this is not the case, the visual aid should be amended and re-tested until an appropriate image is achieved (Byram and Garforth, 1980; Linney, 1995; Harford and Baird, 1997; Garforth, 1985).

3.3 Dissemination methods used by previous studies

A variety of education methods have been used by different projects to disseminate information, however, few references are available relating to dissemination of knowledge in developing countries, particularly in the field of animal disease, and few have focussed on community–based settings (Mitchell et al., 2001). In the medical field, health promotion methods have involved a range of activities, either alone, or in combination, including awareness raising campaigns, provision of health information and advice, influencing social policy, lobbying for change, professional training, and community development (Speller et al., 1997).

In the field of developing countries projects, eight elements in the technology development and transfer process have been identified, which include world stock of knowledge, science (or basic research), technology generation, testing, adaptation, integration, dissemination, and adoption/diffusion (Ruttan, 1987, cited by Betru and Hamdar, 1997). It has been suggested that research organisations should start with the world stock of knowledge and continue until the technology is fully integrated within a social system. In contrast, it is suggested that extension, should start from the stage of technology testing, and continue until the innovation has been adopted by farmers (McDermott, 1987, cited by Betru and Hamdar, 1997).

Some projects have intentionally targeted children in order to influence their knowledge about a subject, and through them to then indirectly influence their parents (Yuan et al., 2000). Many programmes, however, have relied merely on transmission of knowledge in the hope that this will modify behaviour, despite the fact that it has been suggested that knowledge alone is inadequate in modifying behaviour, and that there are four key components to instigating actual change: knowledge acquisition, skills development, attitudes development, and motivational support (Mitchell et al., 2001). Other programmes have resorted to vertical teaching methods that may lack effectiveness when educating adults (Gagne, 1970, cited by Sudre et al, 1999; Knowles, 1970, cited by Sudre et al., 1999).

One method of dissemination which is gaining interest in the field of agricultural extension is that of video (Garforth, 1985), and it has also been used successfully in the medical field, often in combination with other methods such as booklets, and counselling, to disseminate health information about disease, particularly asthma and sexually transmitted diseases (STD) (Sweat et al., 2001; Windsor et al., 2000; Torabi et al., 2000; O'Donnell et al., 1998). It has been shown that video can provide an effective (Torabi et al., 2000; O'Donnell et al., 1998) and affordable (Torabi et al., 2000) method of educating a large number of people, and may, therefore, provide a valuable tool when there is a shortage of funds, trained teachers, or information (Torabi et al., 2000). In addition, video has been used to overcome problems associated with delivering health messages to linguistically and culturally diverse populations (O'Donnell et al., 1998). It has also been shown that some students find video to be a preferable method of education to formal lectures (Torabi et al., 2000).

Although the majority of studies have been carried out in developed countries, one study in China used video, in combination with a cartoon booklet, to educate schoolchildren about schistosomiasis (Yuan et al., 2000). The results of this study showed that the combination of video and booklet had a significant effect both on the children's knowledge about the disease, and also their behaviour in relation to avoidance of exposure to the disease, such as avoiding swimming in infected areas of water (Yuan et al., 2000). Yuan (2000) also hypothesised that the use of media, rather than didactic methods of education, would enhance learning by entertaining children and stimulating them to explore and act on the ideas presented. Results from the study lead to the conclusion that children were able to extract information presented to them in a non-didactic manner (Yuan et al., 2000). Yuan also stated that, at the time of publication, there were no other examples of the use of videotapes in health education for the control of parasitic disease in poor countries.

One study in Sri Lanka showed that radio was an effective method of increasing knowledge about the use of insecticides in paddy cultivation (de Silva and Garforth, 1997), whilst a further study in Nigeria showed that radio was also the main method of mass media by which farmers gained agricultural information (Egbule and Njoku, 2001).

A further study undertaken in a developed country, aimed at educating paediatric residents about the correct installation and use of child car safety seats (Tender et al., 2001). This study involved a participatory teaching format in which residents in the intervention group attended a lecture, observed a video, and installed a child safety seat under supervision of a qualified instructor, whilst those in the control group received no training. The outcome of the intervention was knowledge level, and results showed a highly significant increase in knowledge amongst the intervention group, whilst that of the control group showed no significant difference. In addition, this study suggested that the intervention also affected behaviour of the residents, by increasing the likelihood that they would discuss car safety seats with parents during routine paediatric consultations (Tender et al., 2001).

Video was also shown to be effective in educating Russian teenagers within secondary schools about HIV and Acquired Immune Disorder Syndrome (AIDS) (Torabi et al., 2000). An intervention group that had been shown a video, was compared to a control group which had received only the standard sexual health academic programme. The study showed that there was a statistically significant improvement in the attitudes and knowledge concerning HIV/AIDS of the intervention group compared to the control group, however, there was no change in practices relating to prevention of HIV/AIDS between the groups. The study also highlighted the fact that the results did not provide any evidence about the long-term impact of video education, and also stated that video education cannot provide a substitute for co-ordinated and comprehensive school health education (Torabi et al., 2000).

A combination of video, booklet and counselling was also shown to be effective in an American study aimed at educating pregnant women about the dangers of smoking, which showed that significantly higher proportion of patients in the intervention group gave up smoking than those in the control group (Windsor et al., 2000).

An American study into video-based patient education about STD showed that respondents exposed to an educational video had a significantly lower rate of new STD infection than those in the control group during a period of monitoring of, on average, seventeen months (O'Donnell et al., 1998). Results showed that there was an immediate knowledge and attitudinal change amongst those exposed to the video, and that, in addition, there was a long term behavioural change which lead to a reduction in the incidence of repeat STD infection.

A study concerning education of high school pupils in South Africa about HIV/AIDS showed that drama had a positive impact on knowledge towards HIV/AIDS (Harvey et al., 2000). Significant improvements in knowledge and attitudes were demonstrated in pupils who had received a drama-based education programme when compared to pupils who had received a booklet-based education programme, however, changes in behaviour were not shown to be significant. In contrast, only minimal impact was seen with the educational booklet-based programme, with a degree of improvement in knowledge, but no significant change in attitude being seen when compared to baseline knowledge prior to the intervention. Similar results were seen in a study in Tanzania involving a school education program about HIV/AIDS, which included discussion, artwork, poetry and drama. At the follow-up survey twelve months later, significant changes were seen in knowledge and attitude, but not in behaviour (Klepp et al., 1997).

One rural Ugandan medical study evaluated four channels, drama, video, community educators and leaflets, used in a community based Information, Education and Communication (IEC) intervention for HIV/AIDS. This study showed drama to be an effective and popular method of knowledge dissemination about HIV/AIDS in which live, or video-taped, plays were shown in villages, in combination with education by community educators (CE) and leaflets (Mitchell et al., 2001). The plays were reported to be popular, and people attended them both for enjoyment and in the expectation of receiving new information. Following viewing of the drama, respondents were able to state specific and positive messages from the plays, and also to remember these messages after a period of at least three months. Mitchell (2001) did, however, state that although drama and video provides a method of reaching a wide and diverse audience, this can be counteracted by the fact that the message must be acceptable and relevant to a cross-section of the community and there is, therefore, little opportunity to target messages at specific groups (Mitchell et al., 2001).

In the same study by Mitchell et al (2001), CE were members of the community selected by the project and trained about HIV/AIDS. Community educators were shown to be an effective method of knowledge dissemination, and the didactic method of teaching used by many CE was not seen to be a problem, as many of the target population were accustomed to such a traditional method of teaching. Some criticisms of the method, however, included the fact that access to CE was not equal, as they were more likely to avoid the higher status, highly educated and wealthy, members of the community; and were also more likely to avoid elder members of the community, particularly those within their own family. Some villagers also found it difficult to accept that a member of the community, who they had known for many years, could suddenly become an 'expert' about a subject. Mitchell (2001), therefore, states that careful selection of CE is vital, and, in order to maximise acceptance, should be based largely on an individual's respectability within the community. Existing relationships within villages are, however, likely to affect accessibility of CE, and this problem may be difficult to overcome. The likelihood that messages are understood may be increased by providing an opportunity to ask questions at some point during the dissemination process, however the presence of large and mixed audiences may act as a deterrent to this, as can unfamiliarity of an audience with such practices (Mitchell et al., 2001). Community education by CE, particularly on a one-to-one basis, was found to provide better opportunities to ask questions and resolve misunderstandings than drama and video.

Leaflets were also used in the study by Mitchell et al. (2001), however, despite widespread circulation, and recognition by respondents, the success of leaflets was questionable. A number of reasons were suggested for this, including lack of interest in the leaflet, inability to ask questions or resolve misunderstandings, and poor literacy and a lack of reading culture within the community. It has been suggested, however, that leaflets may have a role as a reference guide for consultation in the future (Mitchell et al., 2001).

Other education methods which were shown to be effective in a study concerning onchocerciasis in Nigeria included information media, which comprised posters, hand megaphones and town criers disseminating information; and social networks which involved disseminating information to key representatives who were then responsible for further dissemination (Oladepo et al., 1996).

T-shirts have been used by one study to increase the visibility of the program and to help to initiate increased communication about a subject (Klepp et al., 1997).

It has been suggested (Garforth, personal communication, 2000) that an individual's previous level of exposure to television (TV) and video may influence the outcome of a video based dissemination programme. It is thought that individuals accustomed to watching TV or video regularly, may find a video presentation less novel, or stimulating, than an individual who has rarely seen such a medium. This may be of relevance if comparing a wealthy urban individual owning their own TV, to a poor individual from a non-electrified rural village who has never previously experienced TV. It is also suggested that the transmission of information by video is more effective if preliminary discussion has established either questions in the learners' minds, or a desire for information contained within the video. There is also evidence that video is more effective in disseminating information when it is followed by discussion, allowing clarification of points, and answering of questions raised by the video (Garforth, personal communication, 2000).

3.4 Aims

A major aim of the project was to produce dissemination materials that were appropriate, acceptable, and effective for the dissemination of mastitis facts to a number of individuals associated with smallholder dairying in Tanzania, including those with limited, or no, literacy skills.

3.5 Study background

A number of materials were developed for use during the various dissemination stages of the project. It was recognised that such materials should be acceptable and appropriate for the target audience, and were, therefore, designed with these points in mind, and following consultation with Tanzanian colleagues, and observation of existing educational materials and household contents amongst smallholder farmers. The materials developed included a diagrammatic poster, diagrammatic handouts, videos, pens and t-shirts. Different combinations of the materials were then used for a residential Mastitis Training Course (MTC) and village video screenings in Iringa, and for the strategic use of six different combinations of dissemination materials in Tanga.

The stimulus for producing the poster came following observation of existing decorations within Tanzanian smallholder homes during the exploratory survey visit. In most houses, in both urban and rural areas, the only decorations on the walls were poster-sized calendars that had been produced and distributed by NGO in the area, whilst some houses also had pages of magazines or newspapers adorning the walls. A particularly eye-catching example of a calendar had been produced by SHDDP, containing vivid and colourful illustrations. It was felt that a colourful poster would, therefore, be a good way of promoting awareness of mastitis, and advertising the project's interest in the study areas. Production of a simple poster, rather than a calendar, was chosen in the hope that this might be displayed for a longer period than a twelve month calendar, and also had the advantage that the month of distribution to farmers was not important.

The use of video as a dissemination method was chosen as it was hoped that it would provide a visual, attractive, and memorable method of disseminating key facts about mastitis. Video also provided a method of transmitting consistent, accurate information to as large an audience as possible at any one time, in a form that it was hoped would be easily understood. During the project exploratory visit, an evening video screening of a feature film was witnessed in one rural Iringa village, and it was noted that the screening constituted a major village event, with the majority of the village in attendance. It was, therefore, hoped that a mastitis video screening, in conjunction with a video for enjoyment such as a feature film or music video, would form a 'social occasion', particularly in rural areas. A further advantage of this method was that certain members of the community, in particular employed cattle attendants, who were a particular target audience for dissemination, would be better able to attend such an event occurring in their own village, rather than a formal training course elsewhere. By creating a village event, it was hoped that a wide variety of other villagers would also be able to attend, including wives, children, and other villagers with no direct association with dairying, and that the content of the video would then stimulate subsequent discussion amongst villagers, to further aid dissemination of mastitis knowledge.

The diagrammatic handouts were devised in order to provide visual images that, it was hoped, would be remembered more easily than simple text, and would also be easily understood by those with limited literacy skills. The diagrammatic handouts were also felt to be an important aid for subsequent indirect dissemination of knowledge to fellow villagers.

It was hoped that a project logo would provide a consistent message that could be incorporated into a number of project materials, in order to raise awareness of both the project, and the disease itself.

Pens were selected as a simple dissemination material as a result of observation of the acute shortage of stationary items available at an affordable price to many Tanzanians, particularly those in rural areas.

3.6 Project dissemination materials

3.6.1 Project logo

A short and simple key message concerning mastitis was devised for the project logo, which consisted of "Ugonjwa wa kiwele = Upungufu wa maziwa", or "Mastitis = Poor milk production". This logo, in combination with a diagrammatic image of a dairy cow (Appendix 2), was used on project pens and t-shirts, and was also incorporated into the front covers of diagrammatic handouts, questionnaires, and also the final edited version of the project video .

3.6.2 Poster

In order to promote awareness of mastitis to a large number of people, in an attractive, colourful, and easily recognisable form, an A2 sized colour poster was produced, which was intended to form the backbone of a DFID 'Mastitis Awareness Campaign'. The poster diagrammatically illustrated the main effects of mastitis of concern to Tanzanian smallholder farmers and the general public, and was annotated in Kiswahili (Appendix 3). The possible effects of mastitis illustrated on the poster included decreased milk production, risk of spread of mastitis to other cows or other quarters; decreased keeping quality of milk, risk of rejection of milk for sale, risk of transmission of disease to humans drinking infected milk, and risk of death or culling of the cow. These points were aimed at highlighting the economic and human health implications of mastitis, which it was hoped would stimulate people to take action, and seek further information about the disease. The points were sketched into diagrammatic 'cartoon' representations by the author, and were then translated into final images by a professional artist. One thousand copies of the poster were printed in the UK and then transported to Tanzania.

3.6.3 Diagrammatic handouts

Diagrammatic representations of the main facts concerning mastitis were devised, and, with Kiswahili annotation, incorporated into a handout for project farmers (Appendix 4). In order to provide continuity, the images used were, where possible, similar to those incorporated into the 'Effects of Mastitis' poster. The diagrams illustrated facts associated with the clinical signs of mastitis, transmission of mastitis, prevention of mastitis, action taken on diagnosis of mastitis, and subclinical mastitis.

A laminated form of the handout was produced for EO, with the intention of providing a durable, and weatherproof form of extension material that could be carried to the field and used in discussions with farmers. Financial constraints precluded the provision of laminated handouts to all project farmers, however, a plastic folder was provided with the paper form of the handout, in an attempt to provide some protection from weathering and ageing.

3.6.4 Mastitis Videos

3.6.4.1 Video Production

Pre-recorded mastitis videos available in the UK were not used for dissemination by the project as they were found to be mostly relevant to the intensively managed, machine milked, dairy herds of more developed countries. It was also felt to be preferable to film a project video, in order that incorporation of points that had arisen from cross sectional study findings (Karimuribo, 2002) was possible.

Three different videos were produced by the project, the first, produced in the UK, was intended for use during the MTC to provide a brief visual illustration of key facts about mastitis. The second video, a more comprehensive overview of mastitis and udder management, was intended to disseminate information about mastitis to a wide cross-section of the study population. This video was filmed and produced in Tanzania using genuine examples of smallholder farming situations. Facilities in Tanzania precluded the editing of the video prior to screening, however it was intended that a final video should be produced which could subsequently be used by future projects for mastitis education. This was therefore achieved at the end of the project, by editing the Tanzanian filmed video in the UK, to produce a third, concise mastitis video of approximately twenty minutes duration, with full Kiswahili narration.

3.6.4.2 Short Video

A short video was made in order to illustrate points covered during the MTC. This was filmed on two dairy farms in the UK, however, efforts were made to simulate Tanzanian conditions by tying the cow up, and using hand milking rather than machine milking. As facilities for Kiswahili translation and dubbing were not available, the video was made with the intention of being shown in 'mute' form at the MTC in Tanzania, with a co-facilitator providing live narration in Kiswahili.

Points covered by this video included full palpation of udder prior to milking; washing the hands with clean water; drying the hands with a clean cloth; washing the teats using hands and clean water; drying the teats using one corner of a clean cloth for each teat, and a separate cloth for each cow; inspection of the foremilk from all quarters; use of the California Mastitis Test (CMT) for identification of subclinical mastitis; milking using the five finger 'squeeze' technique rather than the 'stripping' technique; demonstration of reduced milk yield from quarters affected by mastitis; demonstration of post milking teat dipping; and demonstration of a clinical mastitis case on a UK farm in which the cow kicked in response to udder palpation and foremilk inspection revealed thick pus.

3.6.4.3 Tanzanian Video

The second video was filmed on farms in Iringa in order to provide genuine images of Tanzanian smallholder farming situations. It was hoped that the target audience would be better able to identify with such images, rather than a 'mock' situation in the UK. As this video was aimed at farmers and other villagers, it was essential that it be dubbed or recorded in Kiswahili. Although this problem might have been overcome by live narration of a muted tape during screening of the video, this would have required a public address system, and, adherence to a strict script, in order to control the continuity of subject matter covered in each different village. Relevant points illustrated in the video included methods of restraint for milking, methods of udder preparation, use of milking salve, and hand milking technique (Appendix 5). A script for the narration of the video had been drafted in the United Kingdom (UK), however extra points were subsequently included which had arisen during the MTC participatory group discussions. Smallholder farms were recruited for filming with the aid of an EO, and included examples of both well managed, and poorly managed farms, and a clinical and subclinical case of mastitis.

The filming was carried out during May 1999, and took approximately one day to complete. A camera operator from a neighbouring NGO was employed to film the video using a handheld video camcorder. A colleague, and fellow project PhD student, was identified as a demonstrator for the video, whilst an SHDDP co-facilitator was identified as a narrator for the video. The 'script' covered points to be mentioned in the narration, and practical points to be demonstrated on film, and these were discussed in detail prior to departure for the farms, and the camera operator was also briefed about intentions for the filming. T-shirts bearing the mastitis project logo "Ugonjwa wa kiwele=Upungufu wa maziwa" "Mastitis = Poor milk production" were worn by the demonstrator and narrator for the filming.

The farms were then visited in the company of the EO, and filming was undertaken. The owner of the poorly managed banda was not made fully aware of his reason for inclusion on the film, and was, therefore, distracted in conversation by members of the team whilst the camera operator and narrator filmed inside the banda. Every effort was, however, made to protect the farmer and farm's identity, hence only the interior of the banda was filmed to illustrate relevant points.

At the third farm it was decided to include conversation with the owner and her cowboy, as this illustrated the full history of the cow's chronic mastitis problem, and also demonstrated the importance of a good relationship and good communication between an owner and his/her cowboy.

The fourth farm was used to illustrate points concerning clinical mastitis, and the affected cow was also suffering from subclinical mastitis at the time of filming. In addition, practices demonstrated by the cowboy on the video, later proved to be a good exercise in 'spotting the mistakes' for viewers during the video screenings.

It had been hoped that video footage filmed during the MTC practical class could also be edited onto the tape, however, this proved to be technically impossible with the facilities available in Tanzania. A compromise was therefore reached, and it was decided that the appropriate short periods of video footage would be shown (with live narration) at the end of the main video screenings. In this way, the excellent clinical footage obtained during the MTC practical class could still be demonstrated at village level.

In total, the video had approximately forty minutes of footage, a length of time, which was considered to be acceptable for maintaining viewers attention. The two additional sections of footage were only five minutes in length.

3.6.4.4 Final Edited Video

The Tanzanian video was brought back to the UK, and edited with assistance from the Media department at the University of Glasgow. Relevant scenes from the Tanzanian video were included, along with other scenes from video footage of the MTC practical class in Iringa, and additional diagrammatic illustrations e.g. of the division of the udder into four distinct quarters. A script was then written by the author (Appendix 6) for narration of the video, which was subsequently translated into Kiswahili by a fellow project PhD student. The translated script was then used by the same colleague to narrate the video in Kiswahili, following careful synchronisation with the video images,. The resulting production provided a concise overview, of approximately twenty minutes duration, of mastitis, udder hygiene and recommended practices associated with milking on smallholder farms in Tanzania. Several copies of the video were produced and distributed within Tanzania and the UK, and it is hoped that the video will be used in the future for further dissemination about mastitis by other interested individuals, or projects.

3.6.5 Pens

The project logo "Ugonjwa wa kiwele = Upungufu wa maziwa" "Mastitis = Poor milk production" was printed in both English and Kiswahili onto two thousand ballpoint pens, produced in the UK at a cost of 18 pence each. These pens were distributed free of charge to project farmers for use during project activities e.g. to make notes during a video screening or village meeting, or to complete a questionnaire. In addition, these pens were distributed to other members of the community to help to raise awareness of the project and the disease. It was hoped that inclusion of a logo on an item such as a pen, which would be carried around and used regularly by respondents, would provide regular reinforcement of the key message contained in the project logo.

3.6.6 T-shirts

The project logo, along with a cartoon image of a cow, was also printed onto twenty t-shirts. Some were worn by team members during village video screenings in order to promote the project, whilst others were given as prizes to EO and project farmers who had made particular effort to further disseminate information to fellow farmers, and also to farmers and attendants who had shown marked improvement in their knowledge, or marked enthusiasm to learn about mastitis.

3.6.7 Lectures

Project team members prepared lectures and presentations concerning appropriate mastitis topics for use during the MTC. These were based largely on their own knowledge and experiences of mastitis, however, every effort was made to make the presentations relevant to the Tanzanian smallholder dairy farmer.

Preliminary findings from the cross-sectional study were also incorporated into the presentations, in order to make them relevant to the local situation e.g. types of teat lubricant used, preparation of the udder prior to milking, and bacterial isolates from cross sectional milk samples.

Project colleagues then translated the presentations into Kiswahili, ensuring that the language and terms used were appropriate for use with the intended audience during the MTC. Presentations were prepared in Microsoft Powerpoint, and care was taken that a small number of points were included on each slide, in order to allow MTC participants time to read each slide. Each slide was then photocopied onto acetates for presentation via overhead projector. The Powerpoint format also allowed a compact, double sided, handout to be made, which formed the MTC 'comprehensive lecture notes' given to every MTC participant.

3.6.8 Visual Aids

Slide photographs and diagrammatic illustrations on acetates were made in the UK to illustrate points covered in the MTC lectures e.g. division of the udder into four distinct quarters, palpation of the udder prior to milking, use of CMT reagent in the diagnosis of subclinical mastitis.

4 KNOWLEDGE DISSEMINATION WITHIN COMMUNITIES OF SMALLHOLDER DAIRY FARMERS IN IRINGA

4.1 Introduction

The general features of both smallholder dairying in Tanzania, and knowledge dissemination are described in previous chapters. This phase of the study was carried out in Iringa urban and rural districts between May 1999 and October 2000, in close collaboration with the Southern Highlands Dairy Development Programme (SHDDP), a Swiss NGO based in Iringa.

Throughout this chapter, 'direct knowledge dissemination' refers to the dissemination of information by the project directly to individuals, whilst 'indirect knowledge dissemination' refers to the subsequent propagation of knowledge throughout a community.

4.1.1 Study site

The site for the work undertaken for this phase of the study was Iringa rural and urban districts, within Iringa region in the Southern Highlands of Tanzania, approx 500 km south west of Dar es Salaam. This region has a moderate, temperate climate compared to that of the Tanzanian lowland coast, and lies between latitudes 07°39' and 08°06' south of the equator and longitudes 35°30' and 36°04' east of Greenwich. The district is situated between 1340 and 2090m above sea level. Iringa district covers 28,619 square kilometres, and is made up of two main areas, lower plains with an average rainfall of 900 mm/year, and an area of higher plateaux with an average rainfall in excess of 1200 mm/year. The long rains usually fall between January and March, with shorter rains falling in October. The region is made up of two different agro-ecological zones (Bureau of Statistics, 1991).

The last national census in 1988 estimated the population of Iringa district to be approximately 446,994 people (84,501 in Iringa urban district, and 362,493 in Iringa rural district), within approximately 248,479 households (20,361 in Iringa urban district, and 71,969 in Iringa rural district), with an average of 4.8 people per household (Bureau of

Statistics, 1991). Assuming a 2.9% increase in population per year (Bureau of Statistics, 1991), the population of the district could, however, now be estimated at 666,986 people (126,089 in Iringa urban district and 540,897 in Iringa rural district).

4.1.2 Agriculture

The last national agricultural census in 1994-1995 estimated the cattle population of Iringa region to be approximately 550,000, of which approximately 5,500 belonged to smallholder farmers. At least half of these smallholder cattle were located within the Iringa urban and Iringa rural districts. It was estimated at this time that the entire Iringa region produced 5,160,000 litres of milk in 1990/1991, with a value of 334,100,000 Tsh (Bureau of Statistics, 1996).

The main cash crops grown within Iringa district include tomatoes, other vegetables, and sugar cane, from which local beer is brewed and sold. Livestock kept by farmers in the area include dairy cattle, local cattle, pigs, goats, sheep and chickens. The primary constraints to smallholder dairy farming include animal disease, lack of feedstuffs and lack of an adequate market for their milk. Cattle on smallholder farms are fed fodder cut from either pasture plots, the roadside or communal grazing areas, crop residues, and maize bran or sunflower cake (Karimuribo, 2002).

Veterinary care for animals in the study area is provided mainly by EO, and a small number of private veterinary surgeons, as described in Chapter One. In addition, basic veterinary care is provided by Village Based Animal Health Workers (VBAHW), particularly in rural areas. Village Based Animal Health Workers have usually received a small amount of formal training about animal health and production, and may diagnose and treat commonly encountered ailments. In addition, VBAHW may also be elected as key representative members of farmer groups within a village, whilst other farmer groups may choose to elect popular, or dynamic, individuals within the village to be their spokesperson and 'motivator'. Such individuals are entitled Farm Motivators (FM), however, in contrast to VBAHW, they do not have any role in the veterinary care of animals.

4.1.3 History of SHDDP

The Southern Highlands Dairy Development Programme, a Swiss NGO operating in Iringa and Mbeya, was formed in 1979, at which time it operated under the name of the Small

Scale Dairy Development Project (SSDDP) (SHDDP, 1998a). The project works within the policy framework of two bilateral partners, the Swiss Agency for Development and Co-operation (SDC) and the Tanzanian Ministry of Agriculture and Co-operatives (MOAC). Originally the emphasis of the project was on the support of the government extension service, coupled with the provision of community-owned bulls of high genetic merit to improve the breeding of local dairy cattle. This approach, however, proved to be unsuccessful, as there was a long time delay before farmers saw the benefits of the improved breeding programs. This was due to the fact that there was a nine-month gestation period before milk was obtained from the cow, and then a period of several years before the improved offspring themselves produced milk. It was also felt that the increased genetic potential of the offspring was often not realised, due to poor husbandry and management; factors which, in addition to disease, also led to the death of many of the improved bulls distributed by the project (SHDDP, 1998a).

In 1985/1986 SSDDP, therefore, changed its strategy, and followed an intensive pocket extension delivery system, which targeted small geographical areas of dairy potential, and selected farmers who, following a one year preparation period were able to provide defined criteria for the care of dairy cattle. These included preparation or development of a pasture plot of one acre in size, construction of a suitable banda, and provision of suitable equipment for tick control such as a spray pump. By establishing contacts with a heifer rearing facility, the project provided these farmers with pregnant heifers of improved breeding at a 50% subsidy. This method showed the impact of improved breeding strategies within a much shorter time than the previous approach. The pocket extension delivery system was chosen in order to provide dairy animals to a number of farmers within the same village, thus enabling the group to assist each other in the care of their cattle, input supply, provision of breeding bulls, and establishment of milk marketing opportunities. One disadvantage of this system included the short follow up period received by farmers from extension staff, which it was felt led to subsequent reinstatement of poor husbandry techniques. In addition, in some areas, the sudden introduction of a number of dairy animals led to pockets of surplus milk, especially in areas where villagers either did not have well developed milk drinking habits, or did not have the purchasing power to afford milk or its products, resulting in disincentives for the project (SHDDP, 1998a).

By 1992/1993, investment in small-scale dairying had become prohibitively expensive for most people, largely due to the fact that the Tanzanian government exerted control over heifer prices. By 1993, the price of a heifer had increased from 5000 Tsh to 150,000 Tsh, which, in addition to the cost of constructing a banda, purchasing a spray pump, and establishing a pasture plot, resulted in an initial minimum capital outlay of 250,000 Tsh being required to enter into a small scale dairying enterprise. It was realised, therefore, that some form of access to credit facilities was necessary to enable the small-scale dairy industry in Tanzania to continue (SHDDP, 1998a).

In 1993/1994 the HIT scheme was introduced, providing farmers with a form of credit-in-kind. The farmers entered into a contract with SSDDP, thereby formalising the agreement. During this time, the project also focused on delivery of an extension service system, in order to complement the provision of the HIT scheme. Farmers under this scheme received a prolonged follow up by extension staff until their HIT loan was repaid, a factor which was believed to result in an improved level of husbandry relative to the previous approach. There were, however, still some areas producing surplus milk, either due to a lack of consumer's ability, or desire to buy milk, or to a lack of communication channels to deliver surplus milk to collection centres distant from the farms producing the milk (SHDDP, 1998a).

It was, therefore, decided that a reorientation of the project was necessary in order to make small-scale dairying more sustainable. In addition, government policies were introduced advocating the stimulation of livestock associations, participation of the private sector in production, processing and marketing of milk, and optimising an extension delivery service.

In July 1996, the onset of phase VIII of the SSDDP project encompassed a number of changes to orientate the project in line with the changing small-scale dairying industry of the Southern Highlands of Tanzania. These changes also led to a change in name of the project, from the Small Scale Dairy Development Project (SSDDP) to the Southern Highlands Dairy Development Project (SHDDP) (SHDDP, 1998b).

The first of the changes instigated was the cessation of distribution of dairy animals by the project, and the emphasis of work changing from focusing solely on small-scale farmers, to facilitating development of the dairy industry by also supporting entrepreneurs and traders.

A complete alteration in the operational methods of the project was also instigated, changing from a governmental training and visit (T and V) methodology, to a Participatory Technology Development (PTD) approach. The T and V methodology involved a heavy 'top down' approach with a formal 'teacher and pupil' approach to education and knowledge dissemination. In contrast, the PTD approach, which is still in use, allowed the farmer to identify his/her own problems, and, through joint efforts, seek solutions appropriate to their own farming system and circumstances. Extension staff helped to facilitate improvements, and the resulting indigenous and demand-driven appropriate technology helped to ensure sustainability. This change in methodology required a complete change in attitude of project staff, facilitators, and farmers (SHDDP, 1998b).

SHDDP now has a template which they use to assess their methods of PTD, and district or regional dairy meetings are used for feedback on PTD methods used by staff, thereby allowing colleagues to share their successes, or to learn from their mistakes. The basic tools used by field staff for monitoring the project are monthly and quarterly progress reports, client databases and field staff diaries. Client databases kept by the project record the number and location of dairying households, dairy farmer groups and dairy business entrepreneurs.

Another change to the project, at the same time as the change in operational methods, was the introduction of two new lines, the Dairy Farmer Group Line and the Dairy Business Line, in addition to the existing Extension Service Line. The Dairy Farmer Group Line aimed to empower group members to improve their learning and organisational capacity in farming systems. It enabled farmer groups to identify their training needs, gaps in their knowledge, and common activities, whilst in addition, the project identified the strengths and weaknesses of each group, group needs, and support services available. The Dairy Business Line was instigated to improve the ability of dairy farmer groups to sell surplus milk. This was achieved by targeting local businesses and entrepreneurs, and giving them encouragement and advice on investment in the dairy industry. The project was able to provide survey results of milk production and consumer patterns to assist in this. The Dairy Business Line also encouraged Dairy Farmer Groups to sell surplus milk by organising marketing channels, and encouraging the take over of input supplies. Of all three main project lines the first priority was given to group and business related activities (SHDDP, 1998a).

By 1998, SHDDP had 5,667 reporting farmers within the entire Iringa region owning 93,648 cattle and producing over 5.3 million litres of milk. Eighty-four extension officers provided extension advice to the 5,667 reporting households within the region during 1997/1998 (SHDDP, 1998b). Within Iringa district, SHDDP had 1887 reporting farmers, producing 2,531,243 litres of milk from a total of 37,839 cattle. Of the total cattle population in Iringa district, 137 crossbred cattle were owned by 61 HIT farmers, 4,157 crossbred cattle were owned by 512 non-HIT farmers, and a further 33,839 local cattle were owned by 1,314 farmers (SHDDP, 1998b).

The project has now been integrated into the regional and district livestock service, with local managers from the Regional Livestock Department now acting as Project managers, and expatriate staff of SHDDP acting only in an advisory capacity. Functioning of SHDDP is due to cease in 2003, and the project has, therefore, aimed to hand over the management of the majority of it's HIT committees to as many farmer groups as possible by this time (SHDDP, 1998a).

4.2 Aims

This phase of the study aimed 1) to review current milking, and milk preparation, practices in order to identify target populations, and target issues, for dissemination in the future, 2) to discuss attitudes and experiences of mastitis with EO, VBAHW and FM, 3) to identify EO's existing methods of treatment for mastitis, 4) to implement knowledge dissemination about mastitis to smallholder dairy farming communities in Iringa using the dissemination materials previously developed by the project (Chapter 3), 5) to evaluate the effectiveness of knowledge dissemination undertaken by the project both in the short-term (one month) and long-term (sixteen months) 6) to assess whether knowledge dissemination about mastitis resulted in changes in actual behaviour in relation to banda hygiene and milking practices.

It was hypothesised that direct dissemination of information by the project to a proportion of the community via a residential MTC and video screenings would facilitate further, indirect dissemination within the community via social networks, and methods such as informal discussion and group meetings, and observation of project dissemination materials including poster, pens and diagrammatic handouts. In addition, the author hypothesised that previous experience of a clinical case of mastitis by a respondent would be likely to be associated with an increased level of mastitis knowledge.

4.3 Materials and methods

Selection of project farmers in Iringa was done by a project PhD colleague whose thesis concentrated on clinical and subclinical mastitis amongst cows in the Iringa district (Karimuribo, 2002). A random sampling technique, involving random number generation, was used to select 110 farmers from a sampling frame of 424 farmers registered with SHDDP between July and August 1998, and who, for logistical reasons, lived within a 45km radius of Iringa town. Selected farmers resided in 28 different villages within the Iringa region, of which, nine were urban, eight were peri-urban and eleven were rural.

Throughout this thesis, project (DFID) visits refer to the monthly visits undertaken by a project PhD colleague during a longitudinal study to investigate and quantify mastitis on smallholder dairy farms in Iringa. These visits consisted of administration of a questionnaire concerning milking hygiene, milk production, changes in management, and the lactational status of each cow, in addition to collection of milk samples for evaluation by the California Mastitis Test (CMT), and bacteriology.

4.3.1 Mastitis Training Programme

A Mastitis Training Programme (MTP) was undertaken in the study area, comprising a residential Mastitis Training Course (MTC), village video screenings, and the distribution of project dissemination materials including posters, pens and diagrammatic handouts. The development of project dissemination materials, and reasons for choosing such methods, are described in the previous chapter.

The efficacy of the MTP for short-term mastitis knowledge dissemination was evaluated by administration of questionnaires to smallholder farmers at a period of one month after the MTP. Follow up evaluation of the efficacy of the MTP for long-term mastitis knowledge dissemination was then carried out at a period of sixteen months after the MTP, using repeat administration of the same questionnaire on project farms, and, where possible, interviewing the same respondent as on the previous occasion. In addition to administration of a questionnaire, an attempt was also made to evaluate actual on-farm practices relating to mastitis, thus direct observation of the hygiene of the banda and the milking equipment was carried out at periods of both one month and sixteen months after the MTP.

4.3.1.1 Aims of the MTP

1) To increase awareness of mastitis amongst smallholder farmers, and other individuals involved in the dairy industry

2) To educate EO about all aspects of mastitis, in order that they may advise smallholder farmers about the disease, and treat cases appropriately.

3) To educate smallholder farmers about the prevention, identification, and spread of mastitis.

4) To promote good management practices to help to prevent mastitis on smallholder dairy farms.

5) To educate those involved in the dairy industry about disease constraints to milk production, and highlight their economic implications.

6) To educate those involved in the dairy industry about milk quality and hygiene.

4.3.1.2 Mastitis Training Course

4.3.1.2.1 Participants

The MTP commenced with a MTC in May 1999 for forty-two delegates from Iringa urban and rural districts. Tutors for the course included principal investigators (PIs) on the project from Glasgow University, Liverpool University, and Sokoine University of Agriculture (SUA), as well as staff from SHDDP. All eleven EO covering the Iringa project study area, along with thirty-four selected VBAHW and FM from villages within the project study area, were invited to attend the course. For villages without an official FM, the chairperson or secretary of the group was invited to attend the MTC. Thirteen of the thirty-four VBAHW and FM delegates of the MTC had also been randomly selected as participants of the study. A letter of invitation to attend the course was sent to selected delegates approximately one month before the course, stating that all meals, accommodation and transportation costs would be met by the project, as these incentives were thought to be important to ensure good attendance levels.

4.3.1.2.2 Content and format

Preliminary discussions between project team members and SHDDP staff regarding the content and format of the MTC were carried out during visits in July 1998, November

1998, and January 1999. Plans were then formed which were finalised during a two-day meeting in Iringa in March 1999.

As SHDDP had been following a 'participative approach' to dissemination of knowledge since 1995, project team members were keen to follow this approach as far as possible. Following discussion with SHDDP colleagues, and the project PhD colleague in Iringa, it was, however, felt that the existing level of mastitis knowledge amongst delegates was unlikely to be adequate to allow a fully participative approach. It was, therefore, decided that some didactic lectures were necessary to convey key information about the subject, which could then be followed by participative discussion sessions.

Presentations for the MTC were exchanged by all relevant parties via e-mail for approval prior to the course. This was felt to be particularly important by project team members in the UK to ensure that lectures were aimed at a level appropriate to the delegates of the course. It was also recognised that it was important that presentations from UK team members were translated into Kiswahili in advance of the course.

4.3.1.2.3 Timing

The course was conducted over a five-day period, between May 4th and 8th 1999. This period of the year was selected as a suitable time to hold the MTC, following consideration of the seasonal crop calendars of farmers, which showed that May was a relatively quiet time on farmers shambas (the plot of land on which both cash and subsistence crops are grown), thus increasing the likelihood of invited delegates attending the MTC.

4.3.1.2.4 Timetable

The MTC commenced with a two-day mastitis programme conducted in English for EO and SHDDP co-facilitators. This was followed by a communal day for all delegates, conducted by SHDDP colleagues in Kiswahili, and covering ethno-veterinary practices, milk quality, and milk processing techniques. The mastitis programme was then modified appropriately and conducted in Kiswahili by SHDDP co-facilitators for VBAHW and FM. A comprehensive timetable detailing all topics covered by the course is included (Appendix 7).

The majority of the course, including lectures and participatory group discussions, was conducted at the Lutheran Centre in Iringa, a conference centre owned by the Lutheran

Church, which was also able to provide overnight accommodation and meals for participants. The practical component of the course was conducted at the Veterinary Investigation Centre (VIC) in Iringa, and at ASAS Dairy Farm, a privately owned dairy farm situated approximately ten kilometres from Iringa. At the time of the practical class, ASAS Dairy Farm milked approximately one hundred and eighty exotic, crossbred, dairy cows, of which a number of animals were affected with clinical and subclinical mastitis, in addition to a wide range of teat abnormalities. In addition, a private veterinary surgeon employed exclusively by the farm, proved to be extremely helpful in assisting with the organisation of the practical classes.

4.3.1.2.5 Dissemination materials

Dissemination materials used during the MTC included the project poster, diagrammatic handouts, short video and pens described in the previous chapter. At the end of the MTC, participants were asked that, upon their return to their village, they disseminate the knowledge received from the course to fellow farmers and villagers, and it was hoped that the dissemination materials would assist this process.

A colour certificate of attendance was produced in the UK for every participant of the MTC, and these were gratefully received (Appendix 8)

4.3.1.3 Village video screenings

4.3.1.3.1 Introduction

In addition to the residential MTC, the MTP also involved village video screenings, which were conducted two weeks after the MTC using the full Tanzanian video that had been filmed in Iringa. Major constraints to the village video screenings were both time (one week) and finances (150,000 Tsh). Only a proportion of villages could therefore be visited, and it was decided to randomly select one village from the area of each EO. It had originally been intended to use the mobile video unit of a neighbouring NGO, however this proved to be impractical as the viewing screen on the vehicle could only be used at night, and co-facilitators were reluctant to assist with screenings in the evenings. In addition, the mobile video unit vehicle was only able to carry two people, and thus the project would have required a further vehicle to transport the rest of the team. As such a vehicle was not available, and there were also insufficient funds to fuel two vehicles, it was decided that the project vehicle should be used, which was able to transport the team, a generator, and a conventional TV/video unit.

4.3.1.3.2 Planning

EO were asked to advertise the screening, and to invite farmers, attendants, and any other interested parties from the selected villages to attend. As there was only one week available for the exercise, two villages per day were timetabled which incorporated one morning and one afternoon screening. A number of factors were considered when devising the timetable for the video screenings. These included the stage of the seasonal crop calendar, which had been accounted for by scheduling the video screenings at a time (May 14th-21st 1999) when farmers were quiet on their shambas, and were waiting for harvesting to begin approximately one month later. As a result, it was hoped that many farmers would be free to attend the daytime screenings. Milking times were a particularly important factor to consider in relation to employed cowboys, as they were less able to be flexible about milking times than cattle owners. Most cows on Tanzanian smallholder farms were milked between approximately 6-7 am and 4-5pm. Full time employment was another important consideration, as many urban cattle owners had full time employment, and were therefore unable to attend screenings during 'office hours' (generally 8am-3.30pm, Monday to Friday). As a result, most urban video screenings were scheduled for Saturday mornings. The venue of the video screening was also considered, with ease of accessibility for intended participants considered to be important, in addition to the religious affiliation of some venues.

Once the timetable had been agreed, copies were distributed to all EO approximately one week prior to the screenings. A covering letter was included which requested that all smallholder farmers in the village, as well as cowboys and other villagers be invited. Extension Officers were also requested to organise an informal meeting with between ten and fifteen farmers or cowboys, of mixed gender and ability, prior to the video screening. This was to enable an assessment to be made of the general level of mastitis knowledge before the video was screened.

In addition to showing the mastitis video, it was decided to take another 'entertaining' video to the video screenings in order to encourage increased attendance. Following consultation with various Tanzanian colleagues about the choice of video, it was suggested that a music video would have the widest appeal to the intended audience. In addition, a video concerning general aspects of zero-grazing, produced by the National Dairy Development Project of Kenya, was also taken to each video screening

4.3.1.3.3 Equipment and team members

Equipment required for the village video screenings included a TV/video unit; a portable 220V generator with appropriate fuel; a voltage stabiliser for the generator (to prevent wide fluctuations in voltage which prevented screening of the video); an extension cable for the generator (of adequate length to prevent the noise of the generator obscuring the narration on the video); and a multi-socket extension cable (with fuse) to connect the TV/video.

There were three team members for the video screenings, including an SHDDP colleague, who had also been a co-facilitator for the MTC, and narrator for the video and, therefore, had good knowledge of the subject, in addition to being experienced in leading informal discussion sessions, and co-ordinating questions. Further team members included the author, who had technical knowledge about mastitis, but a poor level of Kiswahili, so therefore answered questions following the video screenings via translation; and a driver who was also extremely useful for technical assistance with the generator.

4.3.1.3.4 Format

The team arrived at the venue at least forty-five minutes prior to the scheduled screening time, in order to ensure satisfactory set-up of equipment. A project poster was placed in prominent view at the venue, and team members also wore project t-shirts in order to promote the topic.

Following arrival of the 10-15 selected farmers and cowboys, all participants were asked to introduce themselves. Each participant was asked to state how many cows they owned or attended, and for what length of time they had done so. Delegates of the MTC were also asked to identify themselves and were asked to remain quiet during the discussion, unless clarification of points to their colleagues was necessary. General questions were then asked to stimulate an informal discussion about mastitis in order to evaluate the participants' existing level of knowledge about the disease. The co-facilitator translated all discussion in order that the author could take accurate notes, and discussions lasted, on average, approximately 30 minutes.

At one screening, where the majority of participants were cowboys, one technique used to canvass milking preparation techniques, was to ask all participants to hide their eyes, and then raise their hands in response to a question e.g. 'How many of you examine the foremilk before starting milking?'. This technique was intended to provide anonymity for those who were not performing recommended techniques, in order to obtain a representative answer, however at other meetings this approach was felt to be inappropriate for the participants in attendance (e.g. for older members of the community).

Following completion of informal discussions, all other village participants were invited into the venue, and the video screening commenced. At the end of the video screening, participants were asked if they had any questions or comments, and these were discussed and recorded. Participants were also asked if they had observed any practices during the video that were not advisable (these were illustrated by the cowboy on the final farm in the video).

Following all questions, if time allowed, participants were then given the choice of watching the 'zero grazing' or the 'music' video. Prior to departure, project pens were distributed to all participants. Each video screening event lasted, on average, approximately two hours.

4.3.1.4 Dissemination materials

Project pens and posters were distributed throughout the study area, in effort to raise awareness both of the project, and of mastitis generally.

Following the administration of the first questionnaire, all project farmers were given a poster, pen, and diagrammatic handout, and were encouraged to show these to their attendant where appropriate. Plastic strip cups were also distributed to project farmers at this time, accompanied by an explanation of how the cup should be used, and a request that the cup should be used every day prior to milking.

An article about mastitis was written by the author and the project PhD colleague for inclusion in the SHDDP newsletter 'Maziwa', which was distributed to all SHDDP farmers. The article, written in Kiswahili, gave an overview of the disease, and included an action plan of what should be done by a farmer if he/she detected mastitis in their dairy cow. Appendix 9 shows the full English translation of the article.

4.3.2 Assessment

4.3.2.1 Farm practices questionnaire

Information concerning farm practices was collected by administration of a questionnaire (Appendix 10) to project respondents in both July/August 1999, and October 2000. Responses from the questionnaire were entered into a database (Epi-Info version 6.04b) for basic statistical analysis, and figures were plotted using Microsoft Excel .

4.3.2.2 Mastitis knowledge questionnaire

The impact of the MTP on project respondents' mastitis knowledge was also assessed by administration of a questionnaire (Appendix 10) in both July/August 1999, and October 2000. The questionnaire was devised in English and included questions relevant to the mastitis facts imparted by the MTP. The questionnaire was accurately translated into Kiswahili by a Tanzanian project PhD colleague, who was a veterinary surgeon with a sound knowledge of questionnaire design, in addition to both mastitis, and the local terminology associated with keeping dairy cows. During questionnaire administration, open questions were initially asked e.g. 'What signs do you associate with mastitis?', and respondents were allowed to volunteer as many responses as they were able before the interviewer then administered the questions in a closed manner e.g. 'Is a hot udder a sign of mastitis?'. Respondents were able to respond 'yes' (recorded as 'prompted' answers), 'no' or 'unsure' to these closed questions, and all responses were recorded. The outcome of each question therefore fell into four possible categories, namely 'volunteered', 'prompted', 'no' or 'unsure'. A small number of open-ended questions were also included at the end of the questionnaire e.g. 'Do you have any recommendations for further dissemination of this information?' and 'Do you have any other comments?' in order to allow respondents to express their own opinions, and to gain valuable feedback. The questionnaire was piloted on twelve farms, with both farmers and cowboys being interviewed. Appropriate modifications, including modification of questions that were not easily understood by respondents, were then made to the questionnaire before use in the final study.

The questionnaire was administered to respondents on the 110 selected farms at two different time periods, the first being one month after the MTP (n=255), and the second being sixteen months after the MTP (n=192). Where possible, both the family member responsible for the care or supervision of the dairy animals, and, where appropriate, the cowboy of a farm were interviewed. Interviews were carried out simultaneously, ensuring that both respondents were physically separated by some distance, in order that intimidation, particularly of cowboys, did not occur. Respondents were assured that their responses were given in the strictest confidence, and in particular, that responses from cowboys would not be fed back to the farmer. Where possible, the same individual was interviewed in both 1999 and 2000, however, on a number of farms this was impossible, for reasons which included death or illness of the respondent, absence of the respondent, and a change of cowboy on the farm. Interview teams consisted of either the project PhD colleague, or the author accompanied by a co-facilitator. Co-facilitators were given training on questionnaire administration, and were asked to read the questions exactly as written in the Kiswahili questionnaire. Further elaboration of questions was only permitted if the respondent was unable to understand the original question.

The questionnaire was administered on all project farms, in addition to those VBAHW and FM participants of the MTC who were not selected as project farmers. The administration of a questionnaire to the EO was not performed, as it was felt that this might 'insult' the EO, and jeopardise their co-operation, which was essential for organising, and undertaking, visits to project farmers.

It was acknowledged that responses concerning volunteered farm practices and mastitis knowledge were obtained after completion of the MTP, and thus did not account for the baseline level of knowledge prior to dissemination. The history and original design of the study, however, precluded either collection of pre-dissemination data, or inclusion of a formal control group. This matter is, however, addressed in section 4.3.8 of this thesis, in which a control group is defined as those 1999 respondents who had not attended the MTC, a video screening, or a group meeting. A control group comprising respondents who had been exposed to none of the project dissemination would have been preferable, however, the proportion of respondents meeting these criteria was extremely small (n=8).

4.3.2.3 Direct observation of banda and milking equipment hygiene

In addition to the questionnaire, a checklist of questions (Appendix 11) was drafted for evaluation of the hygiene of the banda and the milking equipment. Where appropriate, scoring systems were defined in order to maintain consistency during the evaluation. The checklist was then used to evaluate the banda and milking equipment by direct observation.

Evaluation was carried out by either the author, or the project PhD colleague, as it was logistically impossible for one person to evaluate all farms during the time available.

4.3.2.4 Data storage and analysis

Collected data were entered into Epi Info databases (Coulombier et al., 2001), and this software was used to quantify mastitis knowledge and respondent, farm, village and question variables. Two by two tables and Chi squared tests were used to determine associations between mastitis knowledge and explanatory variables using the Epi Info 6 Statcalc programme (Coulombier et al., 2001). The Yates corrected p-value was used, except when one or more of the expected cell values were less than 5, when the Fisher exact test p-value was used. A critical probability of $p=0.05$ was used throughout the chapter. Comparison of two or more proportions, to determine if they were significantly different, was done in Epi Info 6 Epitable (Coulombier et al., 2001) using the Chi squared test. The Epi Info 6 Epitable programme (Coulombier et al., 2001) was used to calculate 95% CI by the exact binomial method, and figures were drawn using the Microsoft Excel 2000 (Microsoft, 1985-1999) programme.

Multi-level models were constructed to examine the relationship between 'volunteering mastitis facts post-dissemination' (outcome variable) and the different explanatory variables to which respondents had been exposed. This approach was used because data were arranged in a hierarchical manner, and it was necessary to account for, and estimate, the variation attributable to the different levels within the hierarchy. The general hierarchical structure used comprised individual question clustered within farm clustered within village. Owing to the fact that it had only been possible to interview the same respondent in both 1999 and 2000 on a small proportion of farms, two different models were constructed to look at the overall knowledge of the populations in 1999 and 2000, the first used responses obtained in 1999 (one month after the MTP – Model 1) and the other used responses obtained in 2000 (sixteen months after the MTP – Model 2). As binary outcome responses were involved, a generalised linear model with a logit link function was used, which also had the useful property that the exponent of the coefficient was equal to the odds ratio for each outcome variable.

Ideally, a cross classified model should have been used to account for all sources of variation within the dataset, however, due to the size of the dataset, and the relatively low contribution from farm and village level, this was not considered to be necessary. This study only considered simple variation (random intercepts), hence the model considering exposure to two explanatory variables, compared to a third control group, and a nested hierarchy of individual question, farm and village was of the form:

$$y_{ijk} \sim Binomial(1, p_{ijk})$$

$$y_{ijk} = p_{ijk} + e_{ijk} x_0^*$$

$$Ln\left(\frac{p_{ijk}}{1 - p_{ijk}}\right) = \beta_1 + \beta_2 x_k + \beta_3 x_k + \nu_{1k} + \mu_{1jk}$$

$$[\nu_{1k}] \sim Normal(0, \Omega_\nu)$$

$$[\mu_{1jk}] \sim Normal(0, \Omega_\mu)$$

$$x_0^* = \sqrt{[p_{ijk}(1 - p_{ijk})]}$$

Where

i = subscript representing individual questions
j = subscript representing farms
k = subscript representing villages
y_{ijk} = outcome for individual question i in farm j and village k
β_1 = constant (representing log odds in control group)
β_2 = coefficient for explanatory variable 1 (intervention 1)
β_3 = coefficient for explanatory variable 2 (intervention 2)
x_1 = 1 if exposed to explanatory variable 1, otherwise 0
x_2 = 1 if exposed to explanatory variable 2, otherwise 0
ν_k = 'error' term representing village-level residuals (level 3)
μ_{jk} = 'error' term representing farm-level residuals (level 2)
e_{ijk} = 'error' term representing individual question-level residuals (level 1)
Ω_ν = variance of ν
Ω_μ = variance of μ

and

e^{β_1} = Odds Ratio for exposure to explanatory variable 1 (compared to control group)
e^{β_2} = Odds Ratio for exposure to explanatory variable 2 (compared to control group)

The contributions of each level of clustering, individual question, farm and village, to the variance were assessed by fitting intercept only, 3-level models. The proportion of variance attributed to each level was then estimated by calculating the approximation of the intra-class coefficient (ICC) using the latent variable approach and the binary linearisation model (Goldstein et al., 2000). The ICCs for both of the fixed term models were also calculated using the latent variable approach. The latent variable approach assumes that the binary outcome arises from an underlying continuous distribution and that the level 1 variance on the logit scale is $\pi^2/3$.

For both multilevel models, univariable screening of variables was performed for the binary outcome 'volunteering mastitis facts post-dissemination' using the MLWin software (Rasbash et al., 2000). Binomial models were fitted to identify significant explanatory variables ($p \leq 0.05$) for the outcome variable. The estimation procedure used the second order penalised quasi-likelihood (PQL) and residual iterative generalised least squares (RIGLS) algorithm, as these show less bias than other methods of estimation. The OR was calculated by exponentiating the regression coefficient (β) of binary variables. The 95% CI was calculated by exponentiating ($\beta \pm 1.96SE$).

Dummy variables were created for categorical variables, with the most appropriate reference category being selected following univariable analysis for all permutations of reference category (Table 4-6). Final multivariable models for the outcome variables 'volunteering a correct mastitis fact post-dissemination in 1999' and 'volunteering a correct mastitis fact post-dissemination in 2000', were then fitted using a 2nd order PQL method with a backward stepwise elimination procedure, and a critical probability of 0.05.

4.4 Results

Before the project started in Iringa, many farmers were familiar with TBD in their cattle, and both they, and staff of SHDDP, requested that the focus of the project should be on TBD. The project in Iringa, however, focussed on mastitis, with a project PhD colleague undertaking work looking at clinical and subclinical mastitis, whilst the author focussed on knowledge dissemination about mastitis to smallholder farmers. Approximately half way through the project, however, an independent assessment found that both farmers and SHDDP staff were extremely satisfied with the project's focus, and were very enthusiastic about participating in the project (Shaw, 2000). In addition, many farmers who had been excluded from the project as a result of the random sampling selection methods used, requested that they would like to participate in the project

4.4.1 Mastitis Training Course

All eleven invited EO attended the MTC, each of whom was responsible for between 20 and 40 farms within the Iringa district. As a result of the random sampling technique used to select project farms, one EO was not involved in the project, but nevertheless was invited to attend the MTC. Thirty-one of the thirty-four invited VBAHW and FM attended the MTC. Some participants did, however, fail to attend the entire course, and missed certain lectures or discussion groups, however the majority of participants were present at the practical class. Informal feedback from the MTC participants was very favourable, with all saying that they had enjoyed the course and had also found it to be extremely useful, particularly the practical class.

The costs incurred for the MTC are shown in Appendix 12, however the total cost was 2,850,000 Tsh (approximately £2590), which corresponded to 67,857 Tsh (approximately £61.68) per participant.

4.4.1.1 Participative discussion groups – EO

Prior to lectures at the MTC, participative group discussions amongst EO about their experience of mastitis revealed that three had seen a case of mastitis in the previous month, and that all eleven EO had seen a case within the previous year. The clinical signs, treatment, and outcome of the three recent cases were described (Table 4-1).

Case	Clinical signs	Treatment	Outcome
1	1 quarter affected Pus in milk Udder oedema Fever Inappetance	Gentamycin i/m injections x 3 days	Mastitis resolved Decreased subsequent milk yield
2	1 quarter affected initially, but spread to all 4 quarters Hot udder Blood in milk Udder oedema Inappetance	Amoxycillin i/m injections x 5 days Injectable Amoxycillin infused into affected quarters	Initially 1 quarter affected, then spread to remaining quarters. Mastitis recurred 2 days after treatment finished
3	3 quarters affected Clots in milk Udder + teat oedema Painful udder	1) Injectable Streptomycin infused into affected quarters Dexamethasone i/m injection	No response to treatment Treatment regime 2 then instigated
		2) Gentamycin i/m injections x 3 days Injectable Gentamycin infused into affected quarters x 3 days	No response to treatment Treatment regime 3 then instigated
		3) Amoxycillin i/m injections Injectable Amoxycillin infused into affected quarters Dexamethasone i/m injection	Mastitis resolved, but markedly decreased subsequent milk yield

Table 4-1: Mastitis cases experienced in the previous month by EO in iringa attending the MTC. The clinical signs, treatment regimes, and outcomes of each case are shown. (i/m=intramuscular)

The EO who had treated Case 3 (Table 4-1) commented that amoxycillin was his drug of choice for mastitis in urban areas, and that he had found a good response to intramuscular (i/m) and intramammary (i/mamm) combination treatment regimes.

All EO commented that they infused parenteral preparations of antibiotic into the udder using a re-sterilised intramammary syringe. This was done because of the irregular availability of intramammary preparations, and more importantly, because of the expense of these preparations (approximately 1000 Tsh per tube). Project PIs advised EO against using such a practice, as injectable antibiotic preparations are often oil-based compounds, which could lead to permanent damage of lactating tissues if infused into udder quarters.

On closer questioning about treatment practices, it was revealed that EO infused approximately 5ml of parenteral antibiotic preparation into each affected quarter once daily. Intramuscular injections were given at the recommended dose according to estimated bodyweight (e.g. on average ~ 20ml per animal), and this dose was also used if parenteral injections were given in combination with intramammary infusions of the drug. Dexamethasone injection was given at a dose of between 5-10ml per animal, however it was pointed out by project PIs that this method of treatment held a risk of inducing abortion in pregnant animals, and may also be contra-indicated in the presence of severe infection.

The consensus of opinion amongst EO was that their order of drug choice for treating mastitis was: 1) penicillin/streptomycin combinations, 2) gentamycin, 3) amoxycillin

On questioning EO about milk samples for bacteriological culture and sensitivity, the opinion was that these were only taken for difficult, non-resolving cases. Reasons for this included expense (1000 Tsh per sample), and the poor service offered by the local VIC for this procedure, as many samples were contaminated, and there was also a delay in receiving the culture results. EO also commented that it was necessary to initiate treatment before such results were obtained.

Advice given by EO following identification of a mastitis case included: milking the affected quarter last, milking the affected quarter into a different container, and pouring the affected milk into the soil and burying it. Other general advice given about mastitis included: washing hands before milking, washing the udder with warm water, washing the udder using a cloth, drying the udder using a cloth, and using the five finger 'squeezing' milking technique in preference to the stripping technique.

Further discussion revealed that EO had never recommended the isolation of affected animals, and some commented that this would often be extremely difficult in practice. It was also reported that most farmers dried their animals off gradually, by reducing the frequency of milking over approximately 2 weeks, depending on milk yield. Dry cow therapy (DCT) was available in town, but not in rural areas, and was extremely expensive (~1700 Tsh per tube). Teat dip was completely unavailable and was, therefore, not used. Calf suckling was sometimes recommended as a treatment for mastitis, however EO felt that it would be difficult to control the suckling pattern of the calf, particularly between quarters of the same cow. Cows were usually untied and able to lie down immediately after milking, thereby leaving no time for closure of the teat sphincter.

4.4.1.2 Participative Group Discussions – VBAHW and FM

Prior to lectures at the MTC, participative group discussions amongst the thirty VBAHW and FM about their experience of mastitis revealed that no participants had seen a case of mastitis in the previous month, and only four participants had seen a case within the previous year. Clinical signs seen in these cases included blood in the milk, clots and flakes in the milk, swelling of the teats, a painful udder, a hot udder, decreased milk yield and fever. In all cases, advice was sought from the EO, and recollected treatment regimes used by the EO had included intramammary infusions of an unknown drug plus frequent stripping of the affected quarter, and both intramammary and intramuscular administration of oxytetracycline, penicillin/streptomycin combinations, or gentamycin.

One farmer commented that his cow suffered from mastitis every time she calved down, whilst another commented that following a case of mastitis the milk had appeared to be very watery, and the yield had decreased by between one and two litres per day. Participants were unable to discuss mastitis further, however, a number of questions were asked including 'Is it possible for non-lactating cows or heifers to suffer from mastitis?', 'What action should be taken to prevent mastitis in one quarter spreading to other quarters?'; 'How would you check a new cow for mastitis before bringing it onto your farm?'; 'How long does it take for a teat to become completely blocked?'; 'Why would a cow produce a high milk yield in the first lactation, but then a decreased yield at subsequent lactations?'. On further discussion, only five participants reported washing their udder cloths after every milking, and only one participant had ever used DCT.

When presented with the fact that the project's cross-sectional study on mastitis (Karimuribo, 1999) had shown that there was a higher incidence of mastitis in urban areas compared to rural areas, participants volunteered a number of possible explanations for such a finding. These included the fact that most urban farms owned more dairy animals than those in rural areas; there was congestion of cattle in urban areas, particularly at communal grazing areas; milkers on urban farms sometimes worked on more than one farm; cowboys on urban farms were likely to change jobs regularly; many cowboys did not receive relevant training, many owners attended training courses themselves and then failed to pass the information on to cowboys; there was inadequate time for close supervision of cowboys on urban farms; urban owners failed to supervise cowboys closely; and that 'bad' milk from rural areas was sometimes brought to town for sale, and thereby acted as a source of mastitis for urban farms.

4.4.1.3 Action Plans

At the end of the MTC, further participatory group discussions were held with the EO group and with the VBAHW and FM group, in order that participants could devise their own 'action plans' for mastitis in Iringa, which were practical and feasible. Each action plan was presented to the whole group at the end of the discussion, to allow fellow participants to discuss and amend the plan if appropriate.

Action Plan 1 (EO) - For treatment of mastitis cases in Iringa

1. Thorough clinical examination including observation of the udder and milk, and palpation of the udder. Check the number of quarters affected. Check any other cows on the farm for signs of mastitis.
2. Isolate affected cow if possible. If this is not possible, make extra partitions in the banda to separate the affected cow from other cattle, and particularly milking cows and heifers.
3. Take a sterile milk sample for bacteriological isolation (if practical).
4. Start effective treatment as soon as possible

   a) Strip out the affected quarter as often as possible.

   Strip the affected quarter into a container, not onto the floor of the banda.

   b) Administer antibiotic:

   i) If the animal is not sick (mild or moderate mastitis):

   - Infuse intramammary syringes for the correct time course (usually three days, but check individual instructions).

   - Penicillin/streptomycin is a good first choice, if available.

   - Alternative options for antibiotic treatment would be oxytetracycline, or gentamycin, by intramammary infusion.

   ii) If the animal is sick (severe mastitis):

   - Use amoxycillin or cephalexin by injection as first choice.

   - If these drugs are not available, then use oxytetracycline as a second choice, or penicillin/streptomycin could be used as a final choice.

   - Dexamethasone may be used only in cows with very severe inflammation, however there is a risk that this may cause pregnant cows to abort.

   iii) If results of bacteriological examination are available, base the choice of antibiotic on these results.

   iv) Treatment choices are limited by availability in the veterinary input shops.

   v) If animals fail to respond to treatment with intramammary tubes:

- use systemic injections of a different antibiotic to that used previously in the intramammary syringes.

5. Advise on hygienic measures to prevent infection of other quarters, cows or herds.
6. Advise that the withdrawal period for the antibiotic used should be adhered to, and the milk should not be consumed by humans.
7. If there is no response to treatment, then the cow may be dried off using DCT.
8. If DCT also fails to cure the mastitis, then it is possible to "destroy" the affected quarter by infusing 50 mls of a solution of '1 part iodine to 9 parts sterile water'. This will destroy the mammary secretory tissue and should only be used when other treatment options have failed.
9. As a last resort the cow may be culled (if practical).

Action Plan 2 (EO) - For prevention of mastitis in Iringa

In a herd where mastitis is already present:

1. Isolate the affected animal.
   - Move the animal to the pen situated at the bottom of the banda slope
   - Thoroughly clean the pen in which the affected cow was kept
   - Build partitions to separate cows, if necessary.
2. Milk the affected cow, and the affected quarter last.
   - Discard infected milk carefully.
   - Dispose of infected milk away from the banda, and cover with ash to prevent flies spreading infection to other cows.
3. Ensure proper sanitation of milking utensils.
4. Control flies (some acaricides may have a repellent effect on flies e.g. pyrethroids).
5. Cull persistently affected cows, or cows with severe abnormalities of the udder or teats (if practical).
6. Use DCT to help reduce the existing level of subclinical mastitis (if practical).

In a herd which is free from mastitis:

1. Ensure good sanitation of the banda and surroundings.
2. Be vigilant when introducing new cattle to the herd. Check new cattle for clinical mastitis, and if possible for subclinical mastitis.
3. Dispose of manure carefully.
4. Protect cows from teat injuries e.g. from barbed wire or rough floors in banda.
5. Use proper milking procedures, train personnel, ensure no transfer of infection by the milker from one farm to another. Consider use of teat dips (if practical).
6. Perform routine check-ups for mastitis.
7. Clean teats using warm water and hands, and allow teats to dry naturally.
8. EO should make frequent visit to farms to advise about mastitis prevention, including careful inspection of the udder and foremilk prior to milking, advising against using an udder cloth, and building a dedicated site for milking outside of the banda.
9. Use DCT.

Action plan 3 (VBAHW and FM)- For mastitis in Iringa - general

1. There should be good hygiene of the banda, milker, and milking utensils.
2. There should be routine checking of the udder, teats and milk.
3. There should be increased awareness and education of both farmers and milkers.

Action plan 4 (VBAHW and FM)- For prevention of mastitis in Iringa

In a herd where mastitis is already present:

1. Isolate affected animal.
2. Treat affected animal.
3. Ensure good hygiene of the banda and surroundings.
4. Manure should be disposed of far from the banda in order to prevent attraction of flies.
5. Take care during the milking, and the application of milking salve.
6. Ensure good hygiene of the milker.
7. Milk the mastitic cow last, and the affected teat last.
8. Ensure safe disposal of mastitis milk.
9. There should be increased training of cowboys, and they should also be valued by employers and motivated to do a good job.
10. If the mastitis cannot be cured, the animal should be culled.

4.4.1.4 Further dissemination

Informal assessment concerning the extent of further knowledge dissemination undertaken by MTC participants was carried via general conversation and discussion with MTC participants. This concluded that there was large variation between individual EO, VBAHW, or FM, in the efforts made to further disseminate information. One rural VBAHW in Village 25 had organised a number of training course for fellow farmers, which had consisted of lectures, discussions and practical classes. It was, however, noticeable in many urban areas that little effort had been made by MTC participants to organise further dissemination to fellow farmers, and this was particularly relevant to urban participants with full time employment. One urban MTC participant stated that 'He had intentionally refrained from disseminating knowledge to other neighbouring farmers, as they provided him with competition for milk sales, and an increase in their knowledge may result in increased milk production, which would be detrimental to him'. Also of particular interest was the fact that many urban owners, when questioned, informed us that they had intentionally refrained from educating their attendants about mastitis, as they were concerned that an increased level of knowledge would result in the attendant either requesting a salary increase, or leaving their farm in order to find a better job. Many urban owners were, therefore, reluctant to disseminate any knowledge to their attendants, despite the fact that the attendant was usually directly responsible for the udder health of the cow and would, therefore, potentially have had the greatest influence on the incidence of mastitis.

In addition to the informal assessment of further knowledge dissemination, respondents were asked during questionnaire administration whether they had attended a group meeting, and if so, when the meeting had occurred, and who had organised it. From these results inferences were made about the extent of further dissemination carried out by each MTC participant.

Amongst the 11 EO in 1999, only three EO from rural and peri-urban areas, and two from urban areas had organised a group meeting to further disseminate mastitis knowledge within two months of the MTC. In 2000, one of the EO from rural and peri-urban areas had organised further group meetings, whilst two EO from urban areas had done so (Table 4-2).

Amongst VBAHW and FM from peri-urban or rural areas in 1999, 15 of the 19 MTC participants had organised group meetings to further disseminate mastitis knowledge within two months of the MTC. Amongst urban VBAHW and FM however, only one of the twelve had organised a group meeting for further dissemination. In 2000, 11 of the VBAHW and FM from peri-urban or rural areas had organised further group meetings, whilst only two of the VBAHW and FM from urban areas had done the same (Table 4-3).

It was also found during the return visit to Iringa in 2000, that a number of the MTC participants were no longer present in their respective villages. Of the eleven EO who had participated in the MTC, two had moved away or gone for higher education, and of the 31 VBAHW and FM, two had moved away or gone for higher education, and two had, unfortunately, died. In addition, it was reported by a project colleague that one of the EO had also, unfortunately, died early in 2001 (Table 4-2 and 4-3).

Village/ Area(s) covered	Identity of EO	Comment	Further dissemination					
			1999			2000		
			Organised	Date	No project participants	Organised	Date	No project participants
Villages 7, 8, 9, 10, 12	EO 1	Died 2001	Y	May 99	1	N	-	-
Villages 11, 13, 24, 26	EO 2**		N	-	-	Y	July 00	1
Villages 18, 25	EO 3		N	-	-	N	-	-
Villages 16, 19	EO 4		N	-	-	N	-	-
Village 6, 15	EO 5		Y	May 99	1	N	-	-
Village 20, 21	EO 6		Y	May 99	5	N	-	-
Village 4	EO 7		N	-	-	Y	Aug 00	1
Villages 2, 17	EO 8	Moved late 2000	Y	May 99	1	Y	July 00	3
Villages 1, 5, 14, 22, 23	EO 9**	Moved 2000	N	-	-	N	-	-
Villages 3, 27, 28	EO 10		Y	May 99	2	N	-	-

Table 4-2: Further dissemination carried out by EO participants of MTC. **=female participant

Village	Identity of VBAHW or FM	Position within village	Comment	Further dissemination					
				1999			2000		
				Organised	Date	No participants	Organised	Date	No participants
Village 25 (R)	VBAHW 7	VBAHW		Y	June 99	8	Y	Aug 00	4
Village 16 (R)	VBAHW 10 FM 14	Chairperson Secretary		Y N	June 99	1	Y N	Aug 00	3
Village 18 (R)	VBAHW 12	VBAHW		Y	June 99	2	Y	Sep 00	2
Villages 15 and 19 (R)	VBAHW 8 FM 10	Chair person Secretary**	 Schooling 2000	Y Y	July 99	7	Y N	Aug 00	4
Village 4 (R)	FM 9	Secretary		Y	May 99	4	Y	Aug 00	3
Village 12 (R)	FM 12 FM 18 VBAHW 1	Chair person Secretary VBAHW**		Y Y Y	June 99	5	Y N Y	Aug 00	4
Village 3 (R)	VBAHW 11 FM 5	Chair person Secretary**		Y Y	June 99	3	Y N	July 00	4
Village 27 (R)	VBAHW 9 FM 4	Chairperson Secretary	Cow confiscated Moved 2000	N N	-	-	N N	-	-
Village 8 (P)	VBAHW 2 FM 16	VBAHW FM		Y Y	May 99	4	Y Y	July 00	3
Villages 9 and 10 (P)	VBAHW 3 FM 13 FM 15	VBAHW FM** FM**		Y Y N	May 99	6	Y N N	Sep 00	1
Villages 11, 24 and 26 (P)	FM 17 VBAHW 6	Chair person Secretary**		N Y	June 99	1	Y Y	Feb 00	4
Village 2 (U)	VBAHW 5 FM 19	Leader Leader		N N	-	-	N N	-	-
Village 21 (U)	FM 7	Leader**	Died 2000	N	-	-	N	-	-
Village 22 (U)	VBAHW 4	Leader**		N	-	-	N	-	-
Villages 1 and 5 (U)	FM 2 FM 11	Leader Leader	 Died 2000	N N	-	-	N N	- -	- -
Village 17 (U)	FM 8	Leader**		N	-	-	N	-	-
Village 13 (U)	FM 3	Leader		N	-	-	N	-	-
Villages 14 and 23 (U)	VBAHW 1	Leader**		N	-	-	N	-	-

Table 4-3: Further dissemination carried out by VBAHW and FM participants of MTC. **=female participant, (R)=rural, (P)=periurban, (U)=urban

4.4.2 Village video screenings

The large audiences in attendance at many of the village video screenings was encouraging, and feedback obtained from participants was favourable, with many commenting that the screenings were particularly useful for those who were semi-literate, or illiterate. Cowboys were particularly complementary about the screenings, and many commented that it would have been difficult for them to attend a longer, more formal training course.

Audience sizes at village video screenings ranged from seventeen, to seventy participants, comprising a mixture of male and female cattle owners, attendants and other villagers. Children also attended a number of the screenings, thus increasing the audience size, and this fact was particularly obvious in one village where the screening took place in a primary school and had a total audience size of approximately four hundred participants (Table 4-4).

Village/Area	Venue	No participants (inc. children)	Male	Female	Cattle Owners	Cattle Attendants
Village 1 (U)	Primary School	30 (43)	23	7	14	3
Village 26 (P)	Secondary School	23 (53)	20	3	1	20
Village 21 (U)	Private house	25 (40)	17	8	10	7
Village 12 (R)	Primary School	17 (~400)	11	6	17	0
Village 4 (R)	Church Office	19 (21)	13	6	5	6
Village 16 (R)	Primary School	24 (430)	12	12	15	8
Village 15 (R)	Village Office	70 (170)	45	25	30	11
Village 27 (R)	Village Office	60 (100)	40	20	11	1
Total		**268 (1257)**	**181**	**87**	**103**	**56**

Table 4-4: The number, and classification, of participants at village video screenings in Iringa. The totals in the columns 'cattle owner' and 'cattle attendant' do not match the total number of participants, as some participants were villagers with no association to cattle keeping.

In most villages, group meetings prior to the screenings revealed that participants were often only able to discuss mastitis to a limited degree (Appendix 13). It had also been intended to use a matrix ranking exercise to evaluate the level of mastitis knowledge prior to video screenings, however, it became obvious during initial discussions that the level of knowledge amongst most participants was inadequate to perform the intended exercise.

It was often found that at least one participant in a village had experienced a case of mastitis in their own, or their neighbour's cow, and was able to volunteer the associated clinical signs, however, discussion of subjects such as the spread or prevention of mastitis proved to be more difficult for participants. In Village 1, group discussion prior to the screening revealed that one farmer had seen a case of mastitis in his own cow, with clinical signs including painful teats, the cow kicking during milking, and discoloured milk. However, when participants were asked to discuss mastitis further, they commented that they knew very little about the disease and were, therefore, unable to discuss it. It was requested that the project should provide training, and thus the video screening was then commenced. The majority of participants in Village 26 were cowboys, who were able to discuss mastitis to only a very limited degree. At one screening in Village 21, the FM who had previously attended the MTC, proved to be extremely proficient in answering participants questions, and an extremely good candidate for further disseminating information about mastitis, however, it was discovered in 2000 that this particular FM had unfortunately died subsequently.

Some of the questions asked by video screening participants are included in Appendix 14, in addition to the responses given to these questions by project team members. In all cases where a choice of video was given, participants asked to see the Kenyan zero-grazing video in preference to the music video, a fact that highlighted the commonly encountered enthusiasm amongst participants to learn more about cattle keeping. The music video was, therefore, found to be an unnecessary inducement for attendance, although, when shown at the end of some screenings it also proved to be very popular!

The major technical problem encountered during the video screenings was fluctuation in the voltage produced by the generator. At the first screening this resulted in a complete inability to show the video, resulting in a need for improvisation, which took the form of an informal lecture about mastitis, following the guidelines of the video script. Questions resulting from this meeting were also recorded. Following repair of the generator, and acquisition of a voltage stabiliser, further video screenings went without problem.

Lack of communication with villagers about a screening by one EO in a rural area resulted in complete failure of the screening. The EO lived some 15km walk from the village, and his motorbike was out of use. He had, therefore, relied on sending a message via another party, which had failed to be delivered. There was also considerable variation in the methods used by EO to advertise the screenings, which resulted in large variation in the number of participants in attendance. This was particularly obvious in Village 15, where the EO had posted notices around the village, in addition to sending written invitations to selected farmers, and verbal invitations to many other villagers, which resulted in approximately one hundred and seventy participants attending the meeting (Table 4-4). One EO had personal commitments that prevented him from organising a video screening in his area within the time constraints of the project.

Three of the rural villages had unfortunately experienced a death amongst their community the night prior to the screening, and funerals held the following day prevented a large proportion of the village from attending the video screenings. The timing of one peri-urban meeting, scheduled for 4.30pm, resulted in the departure of many cowboys after approximately one hour, as they had to leave for milking duties.

Some screenings had such high levels of attendance that there was a shortage of space within the venue. One screening took place at a primary school, and as most of the pupils requested to see the video, it was necessary to hold the screening outside. Although a shaded spot was selected to site the TV/video, there was a glare on the TV screen that made viewing of the video difficult. It was also found to be impossible to prohibit participants from neighbouring villages from attending video screenings, however this fact was accounted for subsequently in the questionnaire.

The costs incurred for the village video screenings are shown in Appendix 12, however the total cost was 177,000 Tsh (approximately £160.91), which corresponded to 660 Tsh (approximately £0.60) per participant.

Discussion with participants subsequent to the screenings revealed that many felt that the screenings had promoted further informal discussion about mastitis amongst villagers. The screenings also proved to be popular with cowboys, some of who commented that they would otherwise have found it difficult to attend formal training courses.

4.4.3 Dissemination materials

The 'effects of mastitis' poster was displayed prominently in many private homes, and also in a number of other locations in the Iringa area. The mastitis pens were also gratefully received, particularly by cowboys, and were being used on a daily basis by many people. During the second visit to Iringa in 2000, however, none of the project pens were seen by the project team, and on questioning, reasons for their absence ranged from the pen having run out of ink, the farmer's child having taken the pen for schooling, or the pen being mislaid or stolen. It was also noted that some pens which had been given directly to cowboys, had subsequently been confiscated by the farmer, either for their own, or their children's use.

Assessment of a respondent's literacy was found to be extremely difficult as some respondents were embarrassed to answer the direct question "Can you read?" at the end of the questionnaire. Distribution of project pens in 1999, therefore, had an added advantage of being a subtle means of assessing the literacy of a respondent, as pens were given to respondents at the end of the questionnaire administration, and respondents were asked "What does the logo say?". Those respondents who were unable to read the logo, or held the logo upside down, were then gently asked about the level of schooling they had received, and whether or not they were able to read.

4.4.4 Questionnaire - Farm activities

Information concerning the responsibility for dairy activities was collected by questionnaire administration in Iringa between July and August 1999. Respondents were questioned about which member of the household was responsible for the main dairy activities such as cleaning the banda, milking the cows, and selling the milk, and which member of the household was responsible for supervision of these activities. Results showed that the cowboy and the wife were responsible for performing the main activities on the majority of farms, whilst supervision of these activities was most commonly performed by the wife.

Banda cleaning was performed by the cowboy on 68% of farms, and by the wife on 22% of farms. Supervision of banda cleaning was performed by the wife on 45% of farms, and by the husband on 32% of farms (Fig 4-1).

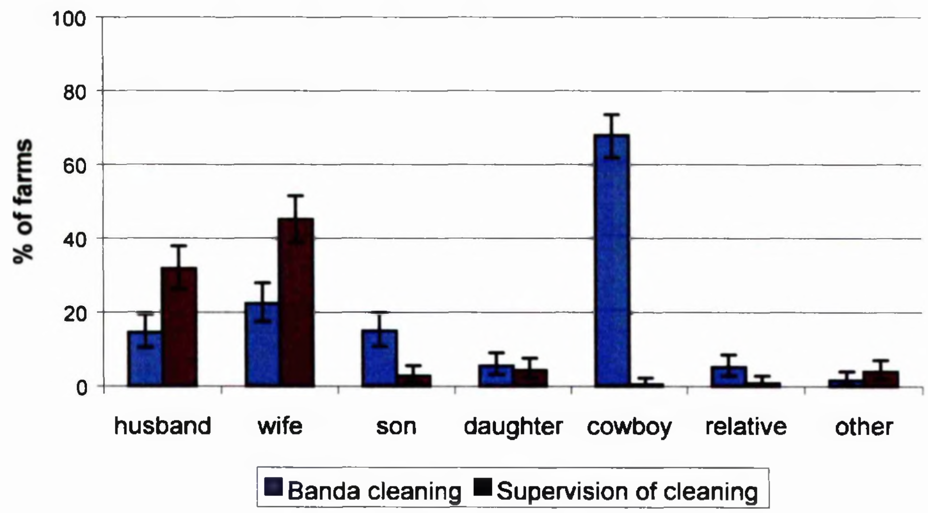


Figure 4-1: 'Responsibility for banda cleaning, and supervision of banda cleaning' on project farms in Iringa. The exact binomial 95% confidence intervals are shown for each response.

Responsibility for other dairy activities showed extremely similar patterns to that seen for banda cleaning, and are therefore not illustrated graphically. Milking was carried out by the cowboy on 59% of farms, and by the wife on 22% of farms, whilst supervision of milking was done by the wife on 40% of farms, and the husband on 26% of farms.

The sale of milk was undertaken by the cowboy on 44% of farms, and by the wife on 31% of farms, whilst supervision of this activity was done by the wife on 19% of farms and the husband on 11% of farms.

4.4.5 Direct assessment – banda

Direct assessment of bandas on project farms was made in both 1999, and 2000. It should be noted that on both occasions, assessment of the bandas was carried out during the dry season, and therefore findings concerning the state of the floor, and cleanliness of the cows, are likely to have differed considerably from those which might have been obtained during the rainy season, when bandas with dirt based floors can be extremely wet and muddy.

Results obtained are summarised in Appendix 15, however it was noted that results obtained for both assessment of the banda, and the milking equipment, varied very little between 1999 and 2000. For this reason, results presented below are those obtained in 1999, and any results of specific interest obtained in 2000 are mentioned only in the text.

Results concerning banda construction showed that the banda roof was commonly constructed of thatch (32% of farms), or corrugated iron (61% of farms), whilst a small number of bandas had roofs constructed of tiles, wood, or a tarpaulin. The extent to which the roof covered the floor space of the banda also varied considerably, with only 28% of bandas assessed in 1999 having complete roof coverage, whilst 61% had incomplete coverage and 12% had holes present. In addition, 5% of bandas assessed in 1999 had no roof at all.

The floor of the banda was commonly composed of dirt (34% of farms), concrete (48% of farms), a combination of dirt and concrete (9%), or wood (7% of farms), and the surface of the floor was often uneven (45% of farms) or broken (25%), as only 30% of bandas had an even floor. The degree of manure soiling of the floor was assessed, and the majority of bandas had a small amount (42%) or moderate amount (30%) of soiling, whilst a large amount of manure soiling was seen in 8% of bandas, 3% of bandas had the majority of the floor covered with manure, and only 16% of bandas had no manure soiling at all. Comparison of 1999 and 2000 results showed evidence of little change. Assessment of the pooling of liquid on the floor of the banda revealed that in 1999, 12% of bandas had liquid pooled in the sleeping area, however this proportion had decreased to 6% in 2000. The slope of the floor of the banda was also assessed, however it was found that in 60% of bandas the slope of the floor was not obvious, and only 12% sloped towards a drainage channel. Extra bedding was provided in 20% of bandas, and a separate sleeping area was provided in 50% of bandas. Forty percent of bandas comprised individual compartments for each cow, and isolation of an infected cow would have been possible in 47% of bandas.

When cows were present in the banda at the time of the visit, the level of manure soiling of the animals was assessed. Thirty four percent of cows had no soiling at all, whilst 42% had a small amount of soiling, 15% had a moderate amount, and 10% had a large amount of soiling. The majority of this soiling was in the region of the legs or the ventrum, and very few animals were observed with manure soiling of the actual udder. In 1999, only 17% of cows had flies present on the time of examination, however in 2000, 50% of cattle examined had flies present on them. In addition, flies were present on 4% of banda floors, 13% of manure heaps and 1% of food mangers.

In 1999 the majority of manure heaps were situated within 20 steps of the banda, with 29% of heaps situated adjacent to the banda, 35% within 5 steps of the banda, and 25% between 5 and 20 steps from the banda. A further 3% of manure heaps were situated between 20 and 40 steps from the banda, and only 8% of heaps were more than 40 steps from the banda. There was little difference in the position of manure heaps observed in 2000.

Drinking was only freely available in 30% of bandas at the time of the visit, and the lack of water on other farms usually resulted from the cow finishing the water provided before more could be collected. A number of farmers stated that they fetched water twice a day, and the amount given to the cow was dependent on the amount they were physically able to carry. Seventy four percent of farms had an area assigned specifically for milking, often comprising a crush, of which approximately half were within the banda. The floor of the milking area was commonly constructed of concrete (41%), dirt (41%) or wood (12%), and 41% of floors were of even construction, whilst 41% were uneven and 18% comprised a broken surface. Restraint for milking was either by a crush, 22% of which were in good condition, 35% of which were in adequate condition, and 7% of which were in poor condition, or by tying by the neck (6%) or the hindlegs (17%).

4.4.6 Direct assessment – milking equipment

Results obtained are summarised in Appendix 15, however it was noted that results obtained for both assessment of the banda and the milking equipment varied very little between 1999 and 2000. For this reason, results presented below are those obtained in 1999, and any results of specific interest obtained in 2000 are mentioned only in the text.

The vessel used to wash the udder was usually plastic (64%) or metal (29%), and 96% of the vessels inspected were clean. Sixty three percent of respondents stated that they used an udder cloth to dry the udder in 1999, however, during inspection of the milking equipment 9% of these respondents were unable to produce a cloth for inspection. Although 98% of respondents claimed to wash the cloth after every milking, of those cloths inspected, only 78% were clean, and 97% were dry, whilst 65% of the cloths were in good condition, 27% in average condition, and 8% in poor condition. Eighty nine percent of respondents also stated that they used one cloth per cow, however, on inspection, this was only true in 79% of these cases.

In contrast, in 2000, 71% of respondents stated that they used an udder cloth to dry the udder, of which, only 70% were able to produce a cloth for inspection. Of the cloths inspected, 69% were washed, 73% were dried, 44% were in good condition, 44% in average condition, and 12% in poor condition. In addition, of the 96% of respondents who stated that they used one cloth per lactating cow, only 81% were able to prove this on inspection. Of those respondents who did produce an udder cloth for inspection, however, 22% produced 'fake' udder cloths that had obviously not been used to dry cows udders. These 'fake' cloths often took the form of embroidered anti-macassers from the backs of armchairs, or pieces of cloth, or clothing, from within the house. Excuses provided for failing to provide an udder cloth for inspection, or for providing a 'fake' cloth for inspection, included 'the owner had locked the milking equipment away', 'the cloth had blown away in the wind' or 'the cow had eaten the cloth' ! On 46% of farms the person responsible for care of the udder cloth was the attendant, although the wife was also responsible for care of the cloth on a further 34% of farms. The most commonly volunteered method (55%) of washing the cloth involved the use of warm water and soap, however 38% of respondents also reportedly washed the cloth with boiling water and soap. Most cloths (98%) were then reportedly dried on a line.

The use of teat lubricant was also investigated, and it was found that during questionnaire administration that 89% of respondents reported using some form of teat lubricant prior to milking. On inspection of the milking equipment, however, only 83% of respondents claimed to use teat lubricant, and of these, only 70% of respondents were able to provide the lubricant for inspection. Excuses provided for failing to do so included 'the owner had locked the lubricant away', or 'the lubricant had recently been used up'. Fifty four percent of respondents claimed to use milking salve as teat lubricant, however, it was found that only 85% of these respondents were able to produce milking salve for inspection, whilst 9% of the remaining respondents produced petroleum jelly, 5% produced cooking oil, and the remaining 1% produced cream. A further 20% of respondents claimed to use petroleum jelly as teat lubricant, however on inspection it was found that this was only true in 87% of cases, and 11% of the remaining respondents produced cooking oil or margarine. On sixty nine percent of farms, the teat lubricant examined was clean, however 31% was contaminated with dirt, and 2% was rancid. The bucket into which the cow was milked was also presented for assessment by 71% of respondents, and found to be clean in 61% of cases, whilst other buckets contained fresh milk, milk scald, dirt or water.

Ninety two percent of respondents reportedly strained the milk prior to sale, of which, 98% stated that they used a tea strainer, and 2% stated that they used a cloth to do so. Only 39% of these respondents were, however, able to produce the strainer for inspection.

4.4.7 Questionnaire - Overall change in practices and knowledge of study population between 1999 and 2000

Respondents' volunteered practices concerning their banda and milking routine, methods by which they had learned about mastitis, and their mastitis knowledge, were assessed by questionnaire in 1999, at a period of one month after the MTP, and in 2000, at a period of sixteen months after the MTP. As one of the aims of this phase of the study was to look at long-term knowledge dissemination within the study area, the frequencies of volunteered responses from all respondents in 1999 and 2000 were compared, to see if the level of knowledge about suggested practices, and mastitis knowledge had changed within the study population. Results showed that, in general, there were greater proportions of volunteered responses from respondents in 2000 compared to 1999, suggesting that the overall level of knowledge within the study population had increased.

It is acknowledged that these results relate to responses obtained after completion of the MTP, and thus do not account for the baseline level of knowledge prior to dissemination. The history and original design of the study, however, precluded either collection of pre-dissemination data, or inclusion of a formal control group. This matter is, however, addressed in section 4.4.8 of this thesis, in which a control group is defined as those 1999 respondents who had not attended the MTC, a video screening, or a group meeting.

4.4.7.1 Farm practices

A number of recommended practices concerning banda hygiene and milking routine were included in the MTP. Responses related to these topics were those volunteered by respondents in response to questions such as "What do you do before milking?". Such responses, therefore, represent respondents' verbally stated routine, which may not always have corresponded with actual practices performed on a daily basis. Results showed that dissemination of facts concerning pre-milking routine was successful, with an increased proportion of volunteered responses being obtained for several facts in 2000 compared to 1999, including a highly significant ($p<0.001$) increase in the proportion of 2000 respondents who volunteered that they 'washed their hands with soap', and 'dried each teat using one corner of the cloth' prior to milking. Results also showed a significant increase ($p<0.01$) in the proportion of respondents who volunteered that they 'dried the udder generally', and significant increases ($p<0.05$) in the proportion of 2000 respondents who volunteered that they 'washed their hands', 'washed the udder', and 'washed the teats and lower udder', when compared to 1999 respondents, although the difference between proportions was small. All other facts associated with pre-milking routine showed no significant difference between 1999 and 2000 results (Figures 4-2 and 4-3).

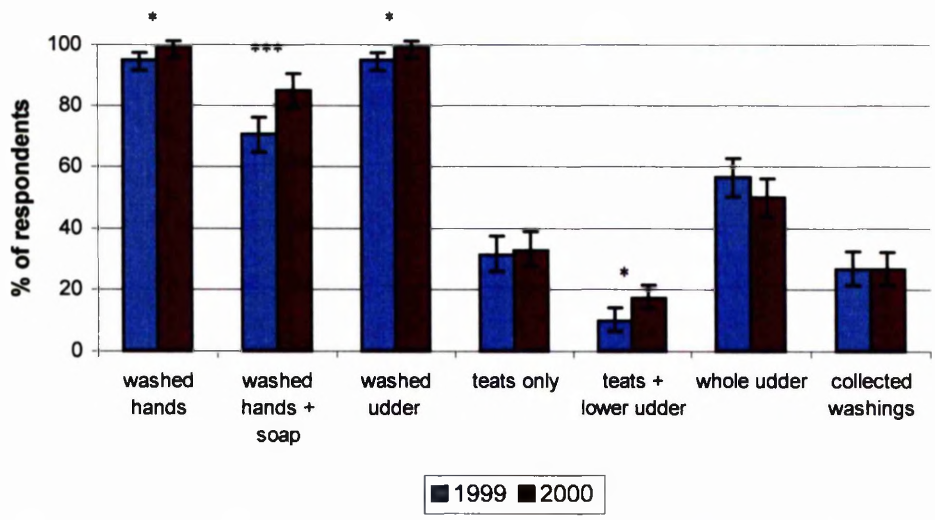


Figure 4-2: 'Pre-milking routine' (1) on project farms in Iringa in 1999 (n=255) and 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where * signifies p<0.05, and * signifies p<0.001**

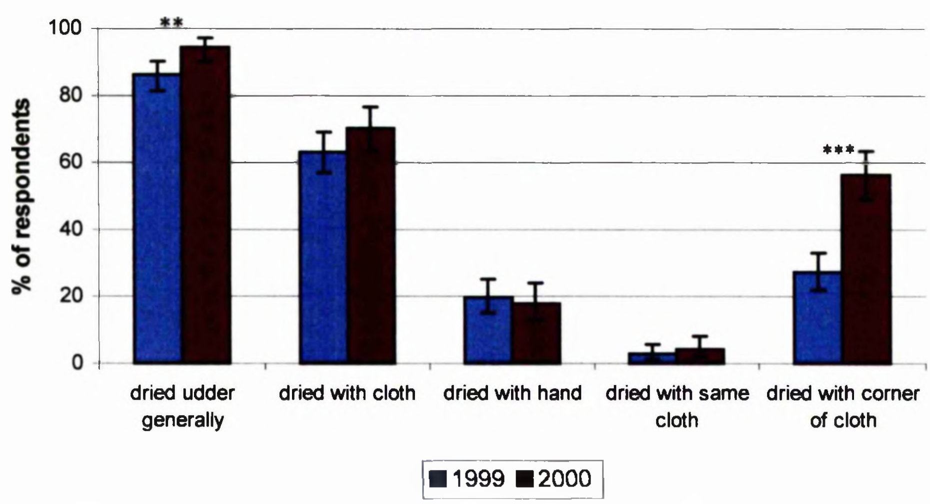


Figure 4-3: 'Pre-milking routine' (2) on project farms in Iringa in 1999 (n=255) and 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where * signifies p<0.001**

Long-term dissemination of facts associated with the udder cloth were successful, with a significant increase (p<0.05) seen in the number of 2000 respondents who stated that they washed the udder cloth twice daily, when compared to 1999 respondents (data not shown). There was also a significant increase in the number of 2000 respondents who stated that the udder cloth was used for only one cow, and a significant decrease ($p<0.05$) in the number of 2000 respondents who stated that two cows shared the same udder cloth (data not shown).

Long-term dissemination of facts associated with the use of teat lubricant was not successful as results showed that there was no significant difference between the proportion of 1999 and 2000 respondents volunteering the use of milking salve in preference to other teat lubricants (data not shown).

Long-term dissemination of the three major project recommendations, that all milkers should 'look at the udder', 'feel the udder' and 'check the milk' prior to every milking, was extremely successful. Highly significant increases ($p<0.001$) were seen in the proportion of respondents volunteering all three of these facts in 2000, when compared to 1999 (Fig 4-4). In addition, there was a highly significant increase ($p<0.001$) seen in the proportion of 2000 respondents volunteering that they would use a strip cup to check the milk, when compared to 1999 respondents (1999=0.4%, 2000=59.4%), and significant decreases in the proportion of respondents who volunteered that they would use either a cup, a one litre plastic container, or their hand to check the milk (data not shown).

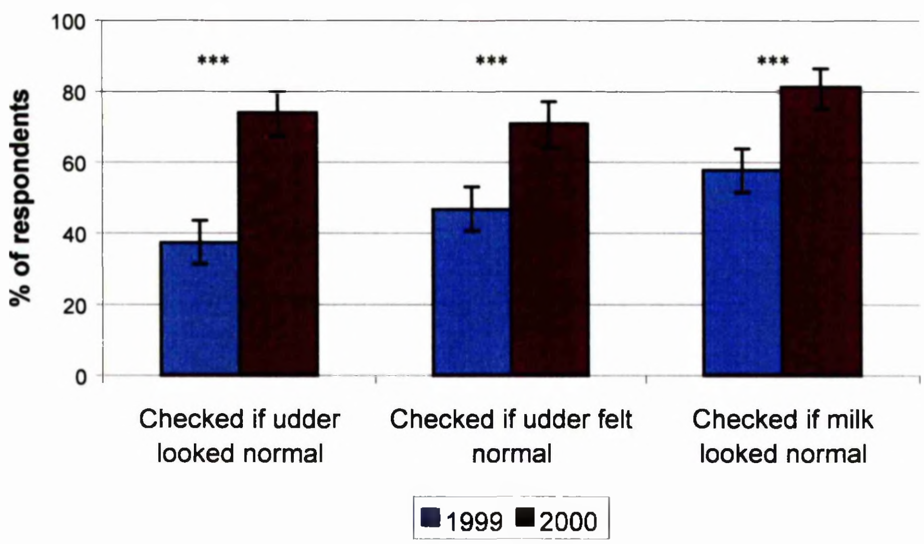


Figure 4-4: 'Methods of checking for mastitis' on project farms in Iringa in 1999 (n=255) and 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where * signifies p<0.001**

Long-term dissemination of facts concerning post-milking routine was of moderate success (Fig 4-5) with a highly significant increase ($p<0.001$) in the proportion of respondents volunteering that they would 'use a teat dip', and significant increases in the proportion of respondents who would 'leave the cow tied after milking' ($p<0.05$) or 'wash their hands' ($p<0.01$).

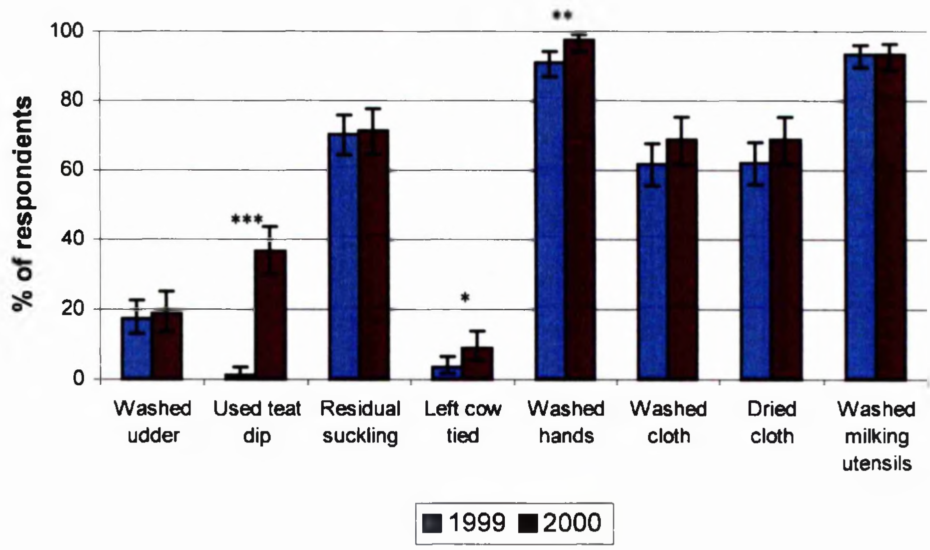


Figure 4-5: 'Post-milking routine' on project farms in Iringa in 1999 (n=255) and 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where * signifies p<0.05, ** signifies p<0.01, and * signifies p<0.001**

Facts associated with drying off showed evidence of successful long-term dissemination, with highly significant increases ($p<0.001$) being seen in the proportions of respondents volunteering that they had 'used DCT', or 'sought advice from the EO' concerning drying off in 2000 when compared to 1999. In addition there was a significant decrease in the proportion of 2000 respondents who stated that they 'did nothing' at drying off when compared to those in 1999 (Fig 4-6).

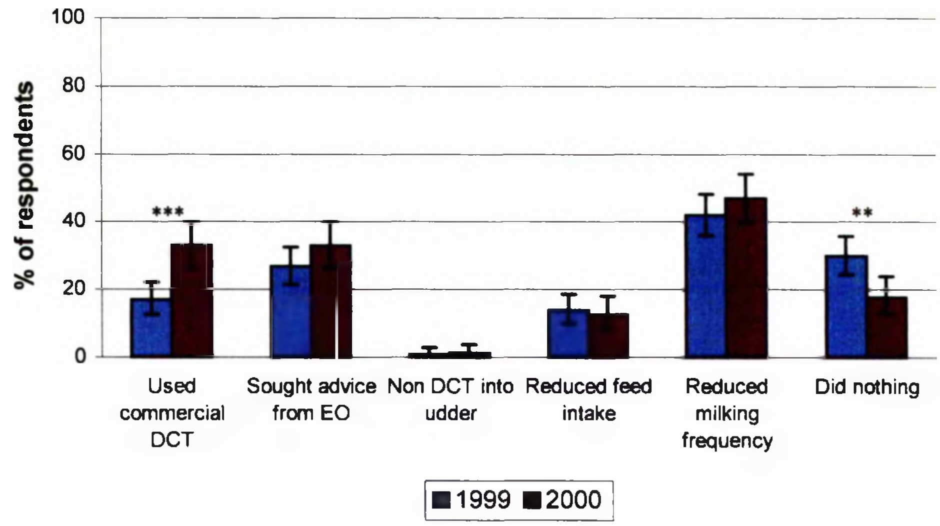


Figure 4-6: 'Drying off routine' on project farms in Iringa in 1999 (n=255) and 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where ** signifies p<0.01, and * signifies p<0.001**

4.4.7.2 Methods by which respondents had learned about mastitis

Results showed a highly significant increase ($p<0.001$) in the proportion of respondents who felt that their mastitis knowledge had increased, as 80% of 1999 respondents felt that their mastitis knowledge had increased within the previous month, and 95% of 2000 respondents felt that their knowledge had increased within the previous sixteen months (Fig 4-7).

All methods by which respondents had obtained mastitis knowledge, except for the project pen, showed evidence of increasing exposure over time, with higher proportions of respondents volunteering each method as a source of knowledge in 2000 compared to 1999. The decrease in exposure to the project pen, was, however, found to be non-significant. Highly significant increases ($p<0.001$) were seen for the proportions of respondents between 1999 and 2000 volunteering that the EO, neighbours, clinical cases, project (DFID) visits, project (DFID) cowboy training, and 'Maziwa' newsletter were methods by which they had learned about mastitis. Significant increases ($p<0.05$) were also seen for the proportion of respondents between 1999 and 2000 volunteering that a video attendant, poster, VBAHW, group meeting, or owner had been sources of mastitis knowledge. Exposure over time was particularly marked for project (DFID) visits, volunteered by 24% of 1999 respondents, and 80% of 2000 respondents (Figures 4-7 and

4-8). The 'Maziwa' newsletter had not been distributed in 1999, but was volunteered as a method of learning about mastitis by 39% of respondents in 2000 (data not shown).

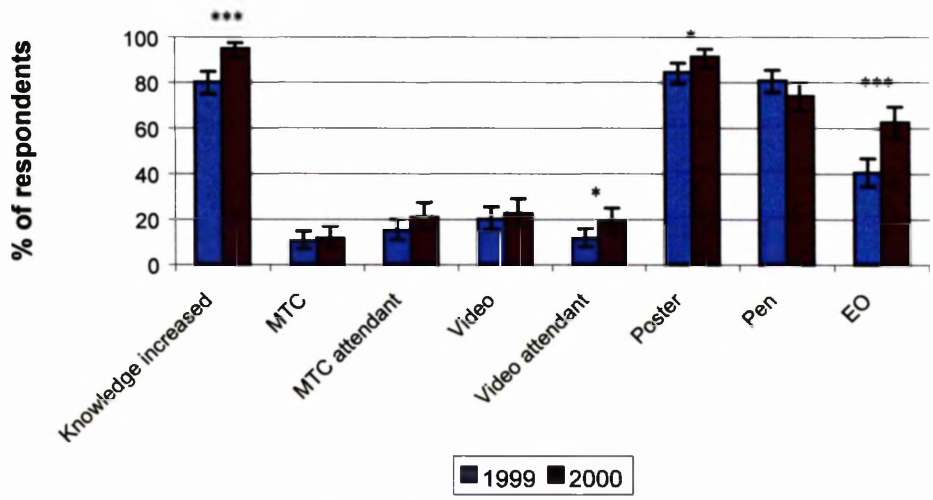


Figure 4-7: 'Methods by which respondents had learned about mastitis' (1) on project farms in Iringa in 1999 (n=255) and 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where * signifies p<0.05, and * signifies p<0.001**

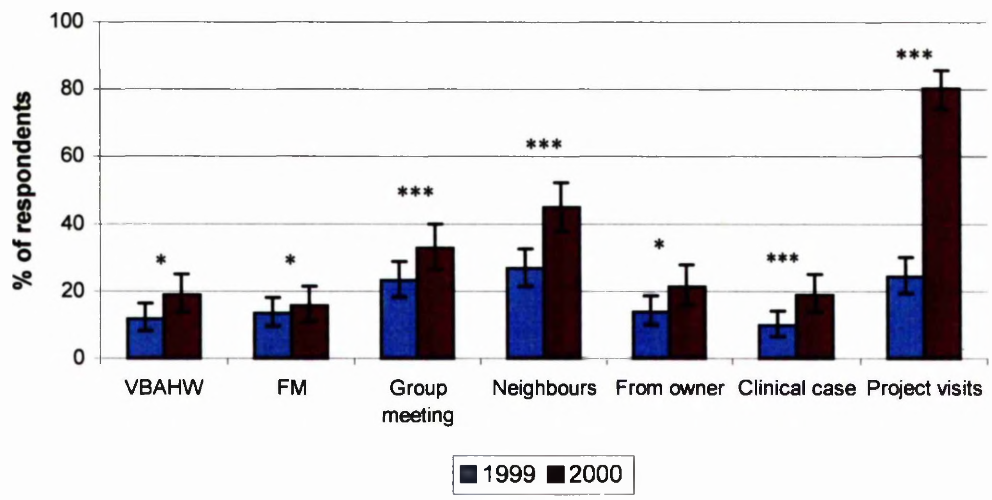


Figure 4-8: 'Methods by which respondents had learned about mastitis' (2) on project farms in Iringa in 1999 (n=255) and 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where * signifies p<0.05, ** signifies p<0.01, and * signifies p<0.001**

Exposure to the project poster had been extremely successful, with 91% of 1999 respondents, and 94% of 2000 respondents stating that they had seen the poster (Fig 4-9). A significant increase (p<0.05) was seen in the number of respondents displaying the poster in their home between 1999 and 2000, and exposure to the poster in other places had also increased over time, with the proportion of respondents who had seen the poster at a neighbour's house (p<0.001), a veterinary input shop (p<0,001), or a milk collection centre (p<0.01) increasing significantly between 1999 and 2000 (Fig 4-9).

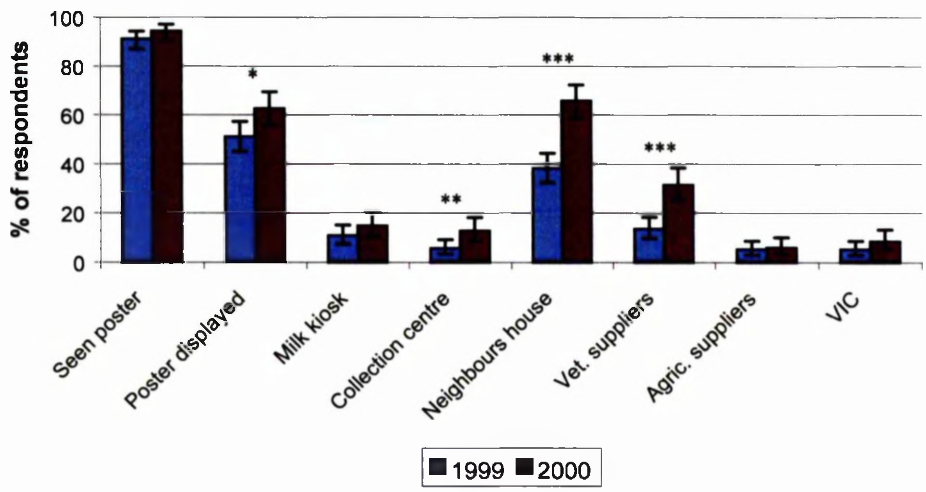


Figure 4-9: 'Exposure to the project poster' on project farms in Iringa in 1999 (n=255) and 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where * signifies p<0.05, ** signifies p<0.01, and * signifies p<0.001**

In contrast, exposure to the mastitis diagrammatic handouts had been extremely unsuccessful, with only 14% of respondents, in both 1999 and 2000, stating that they had seen a mastitis diagram. In 1999, 4% of respondents stated that they had been shown a diagram by their EO, however this proportion had significantly decreased (p<0.05) to zero in 2000 (data not shown).

Exposure to the project pen showed short-term success, with 86% of respondents stating that they had seen the pen in 1999, however by 2000 this proportion had significantly decreased (p<0.01) to 76% of respondents. In addition, respondents' ability to remember the project logo had significantly decreased (p<0.001) from 38% amongst 1999 respondents, to 23% amongst 2000 respondents. In contrast, exposure to the project logo via other formats, including the MTC handout (p<0.05), project poster (p<0.01), project t-shirt (p<0.001) and project recording forms (p<0.001) increased significantly in the long term, although the associated proportions of respondents were relatively small (Fig 4-10).

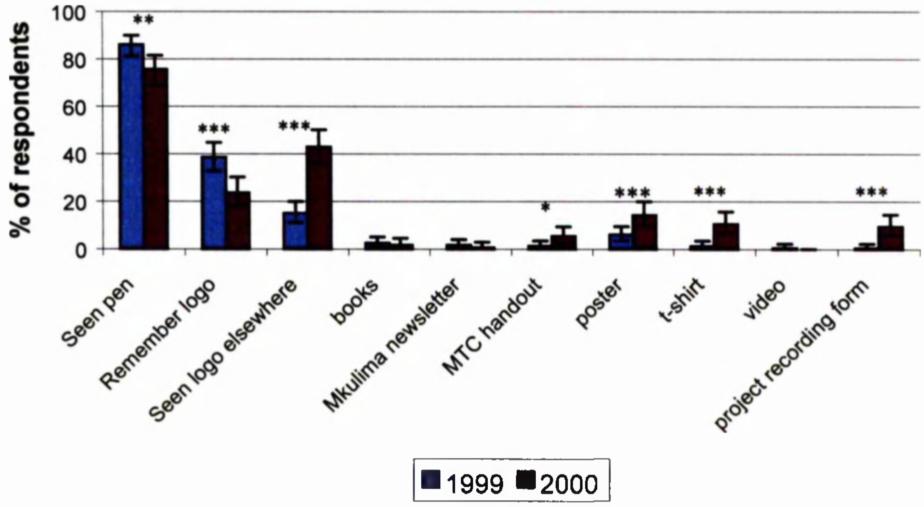


Figure 4-10: 'Exposure to the project pen and logo' on project farms in Iringa in 1999 (n=255) and 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where * signifies p<0.05, ** signifies p<0.01, and * signifies p<0.001**

The 'routes by which respondents felt they had learned most about mastitis' showed variation in responses, with highly significant increases ($p<0.001$) over time being seen for 'project (DFID) visits' the 'project poster', and the 'Maziwa newsletter'. In contrast, other methods including 'EO visits', and 'clinical cases', showed decreases over time in the proportion of respondents volunteering them, however these results were not statistically significant (Figs 4-11 and 4-12).

Throughout this thesis, project (DFID) visits refer to the monthly visits undertaken by a project PhD colleague during the project longitudinal study for collection of milk samples for investigation of mastitis on smallholder farms in Iringa. These visits consisted of administration of a questionnaire concerning milking hygiene and the lactational status of each cow, in addition to collection of milk samples for evaluation by the California Mastitis Test (CMT), and bacteriology.

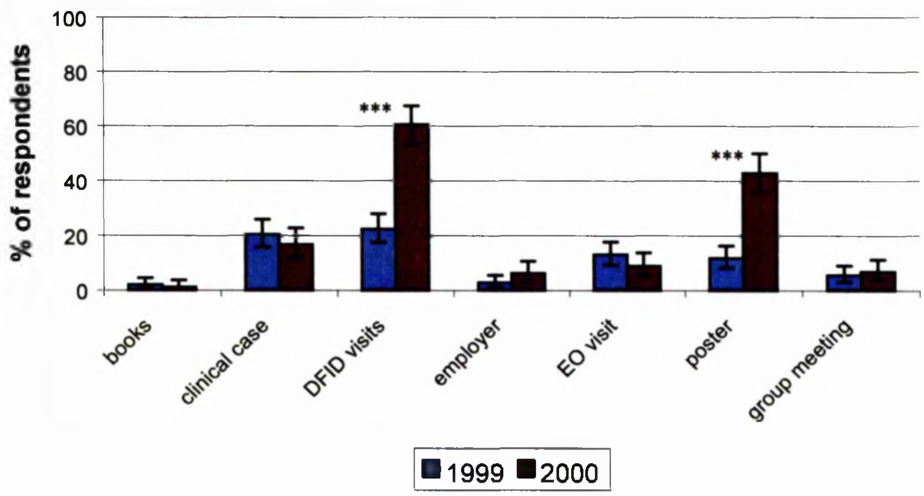


Figure 4-11: 'Routes by which respondents felt they had learned most about mastitis' (1) on project farms in Iringa in 1999 (n=255) and 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where * signifies p<0.001**

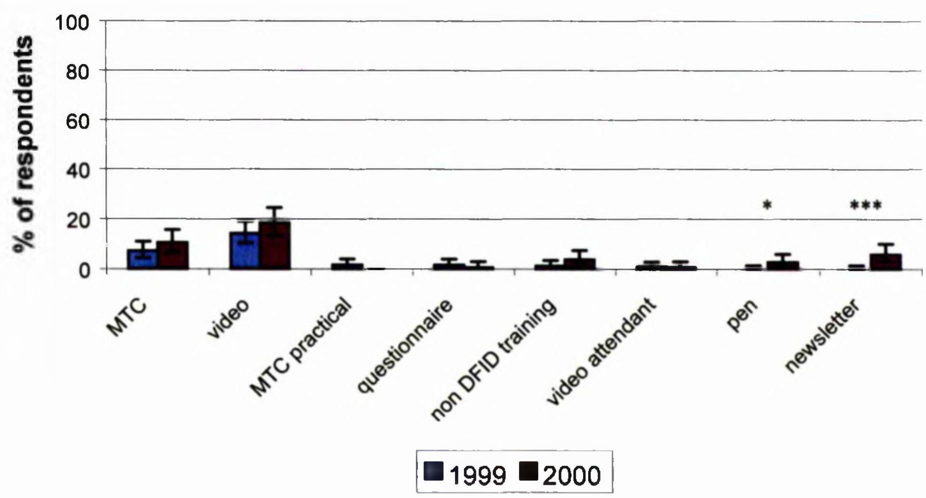


Figure 4-12: 'Routes by which respondents felt they had learned most about mastitis' (2) on project farms in Iringa in 1999 and 2000. The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where * signifies p<0.05, and * signifies p<0.001**

Respondents were also asked to suggest other methods of dissemination that they felt would be acceptable and effective for smallholder farmers. Methods volunteered included radio, exchange visits, articles in newspapers, pamphlets, regular group meetings, and developing songs for choirs to sing with appropriate messages contained in the lyrics.

4.4.7.3 Mastitis knowledge

Responses relating to the mastitis knowledge of respondents were recorded at the time of interview as ‘volunteered’, ‘prompted’, ‘no’ or ‘unsure’. It was, however, decided to use only the volunteered responses during data analysis, as these provided an accurate representation of a respondents’ true knowledge, in contrast to prompted answers whose validity was uncertain. Therefore, all responses in the following graphs relate to volunteered answers given by respondents in 1999 (one month after the MTP) and in 2000 (sixteen months after the MTP). In general, results showed an increase between 1999 and 2000 in the proportion of respondents able to volunteer correct mastitis facts, suggesting that the overall level of mastitis knowledge within the study population had increased.

Long-term dissemination of facts concerning the ‘effects of mastitis’ showed moderate success, with only ‘decreased milk yield’ showing a significant increase ($p<0.01$) in the proportion of respondents able to volunteer this fact between 1999 and 2000. All other changes in proportions for facts concerning the ‘effects of mastitis’ were non significant (Fig 4-13).

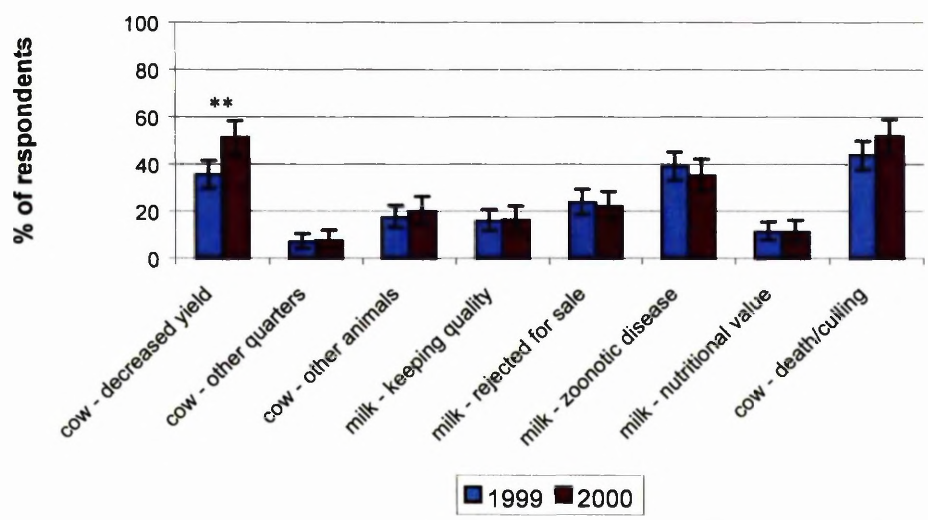


Figure 4-13: ‘Effects of mastitis’ volunteered by respondents in Iringa in 1999 (n=255) and 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where ** signifies p<0.01

Facts concerning ‘signs of mastitis’ showed evidence of extremely successful long-term dissemination, with the increase in the proportion of respondents able to volunteer the facts being highly significant ($p<0.001$) for the facts ‘hot udder’, ‘blood in the milk’ and ‘pus in the milk', in addition to significant increases for the facts 'swollen udder' ($p<0.01$), 'painful udder' ($p<0.05$) and 'altered milk composition' ($p<0.05$). Results also showed a highly significant ($p<0.001$) decrease in the proportion of 2000 respondents able to volunteer 'discoloured udder' as a sign of mastitis when compared to 1999 respondents (Fig 4-14).

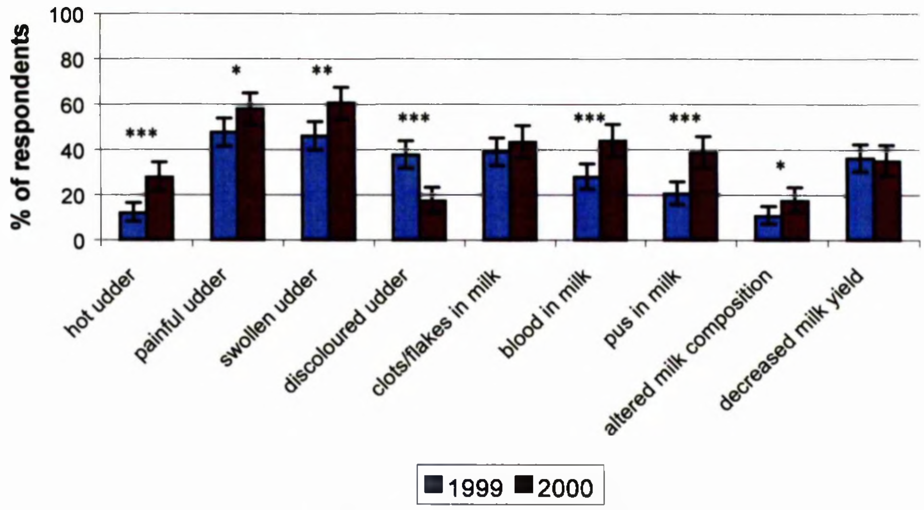


Figure 4-14: 'Signs of mastitis' volunteered by respondents in Iringa in 1999 and 2000. The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where * signifies $p<0.05$, ** signifies $p<0.01$, and * signifies $p<0.001$**

Results for facts concerning the 'spread of mastitis' showed evidence of successful long-term dissemination between 1999 and 2000, with significant increases in the proportion of volunteered responses being seen for 'teat to teat' ($p<0.05$), 'cow to cow' ($p<0.01$) and 'dirty banda to cow' ($p<0.01$) methods of spread (Fig 4-15).

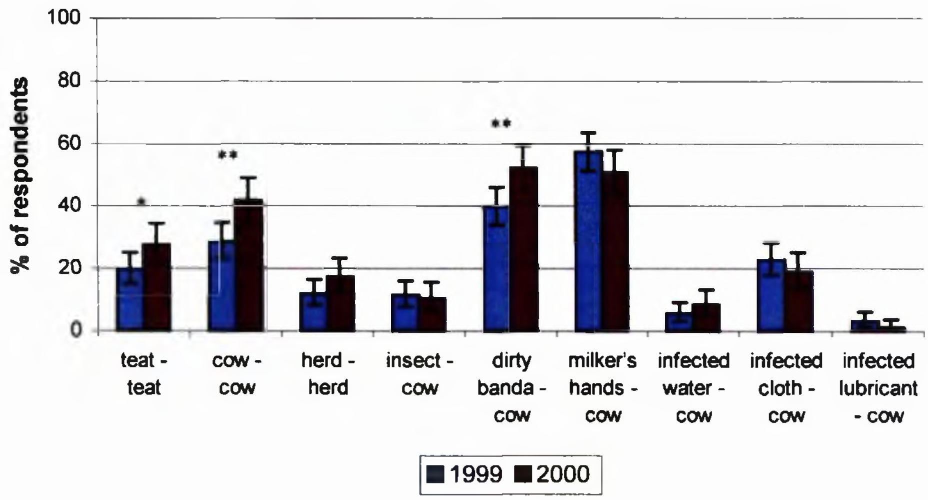


Figure 4-15: 'Spread of mastitis' facts volunteered by respondents in Iringa in 1999 (n=255) and 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where * signifies p<0.05, and ** signifies p<0.01

All facts concerning the 'action taken on identification of mastitis' showed no significant differences between volunteered responses in 1999 and 2000 (data not shown).

Facts concerning the 'prevention of mastitis' showed evidence of poor long-term dissemination, with no significant increases in the proportion of volunteered responses seen between 1999 and 2000, and 'use clean water' showing a significant decrease ($p<0.05$) in the proportion of volunteered responses between 1999 and 2000 (Figs 4-16 and 4-17).

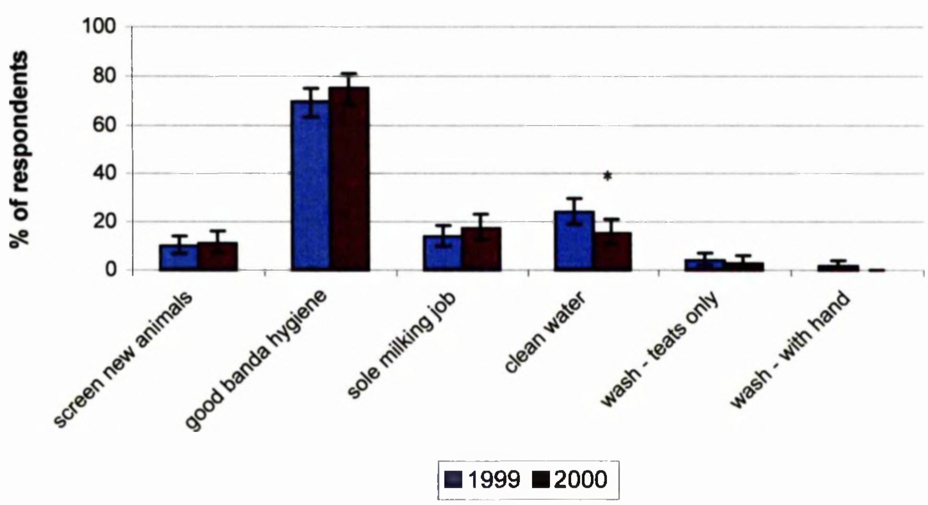


Figure 4-16: 'Prevention of mastitis' facts (1) volunteered by respondents in Iringa in 1999 and 2000. The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 (n=255) and 2000 (n=192) are shown, where * signifies p<0.05

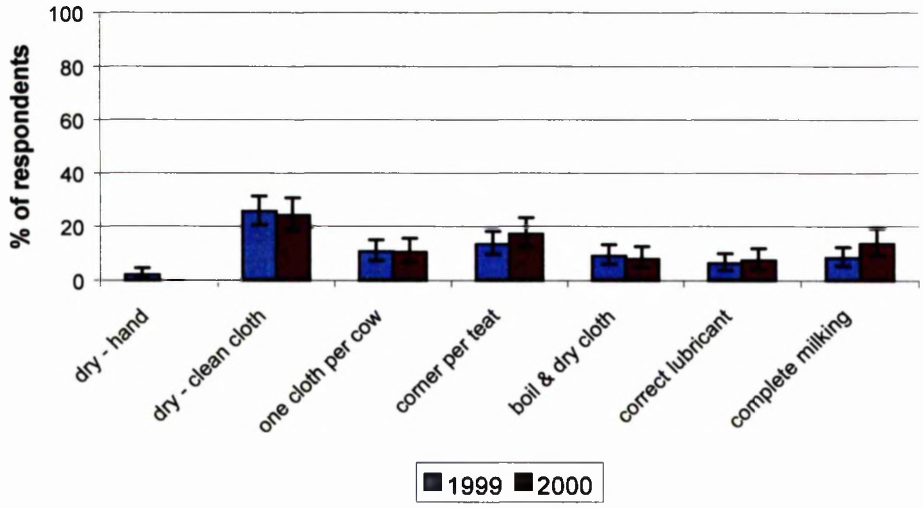


Figure 4-17: 'Prevention of mastitis' facts (2) volunteered by respondents in Iringa in 1999 and 2000. The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 (n=255) and 2000 (n=192) are shown

Long-term dissemination of facts concerning the 'prevention of spread of mastitis' was reasonably successful, with 'isolation of the cow' ($p<0.001$), 'isolation at the bottom of the slope' ($p<0.01$), and 'milk the affected cow last' ($p<0.01$) showing statistically significant increases in the proportion of volunteered answers between 1999 and 2000 (Fig 4-18).

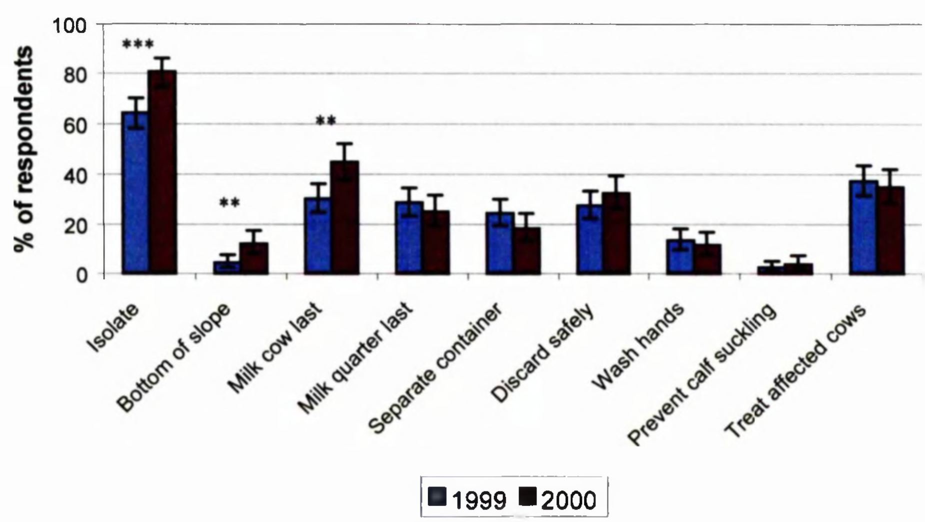


Figure 4-18: 'Prevention of the spread of mastitis' facts volunteered by respondents in Iringa in 1999 and 2000. The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where ** signifies p<0.01, and * signifies p<0.001**

Facts concerning subclinical mastitis showed evidence of good long-term dissemination, as although 35% of 1999 respondents and 54% of 2000 respondents volunteered that they had heard of the condition, very few were able to volunteer further facts about it. The increase in the proportion of volunteered responses was significant (p<0.01), as was an increase in the proportion of volunteered responses concerning the fact that the condition could be chronic (1999=1%, 2000=6%) (Fig 4-19).

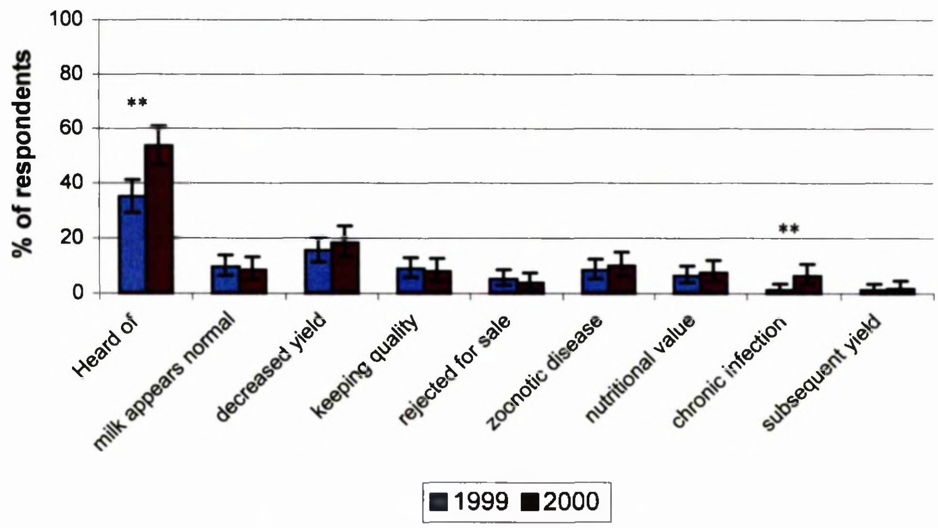


Figure 4-19: 'Subclinical mastitis' facts volunteered by respondents in Iringa in 1999 and 2000. The exact binomial 95% confidence intervals are shown for each response. Significant differences between proportions of respondents in 1999 and 2000 are shown, where ** signifies p<0.01

Results of the 2000 questionnaire revealed that, since the 1999 visit, the cowboy had changed on 45% of project farms, which was equivalent to 57% of the farms that actually employed a cowboy. In addition, amongst the 73 attendants interviewed by the study in 1999, nine were illiterate (12%), and the overall illiteracy rate amongst all respondents was 7%.

4.4.8 Questionnaire - Overall change in practices and knowledge of study population, differences between control and dissemination groups

As discussed previously, it was acknowledged that the results presented in the previous section had no reference to the baseline level of knowledge before dissemination amongst the study population. For this reason, a control group was defined as 1999 respondents who had not attended the MTC, a video screening, or a group meeting. It would have been preferable to define such a group as any respondent who had not been exposed to any methods of dissemination, however, the small number of respondents falling into this category meant that the alternative definition had to be created. Responses from 1999 respondents were, therefore, stratified to include those from control group respondents, and those from non-control group respondents, and the denominator for each group was also changed accordingly. The aim of this exercise was to attempt to illustrate whether the MTP had influenced mastitis practices and knowledge amongst study participants. Only selected results of interest are illustrated below, in order to provide comparison with those results obtained in section 4.4.7.

4.4.8.1 Farm practices

Analysis of results for pre-milking routine by this method gave similar results to those seen in section 4.4.7, with significant differences seen for 'dried udder generally' between the 1999 group and 2000 group ($p<0.05$), as well as a significant difference between the control group and 2000 group ($p<0.01$). Results also showed highly significant differences for 'dried teat with corner of the cloth' between control and 1999 groups ($p<0.001$), and control and 2000 groups ($p<0.001$), however, no significant difference was seen between 1999 and 2000 groups. All other facts showed non-significant differences between the proportions of volunteered answers (Fig 4-20).

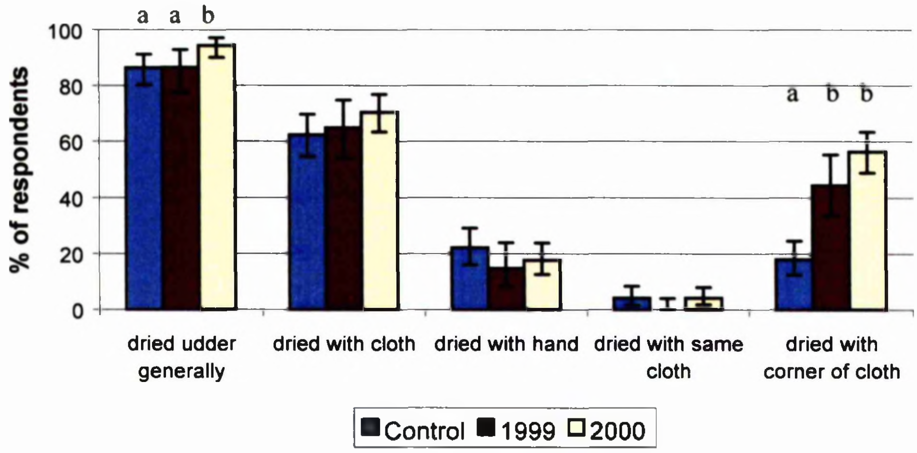


Figure 4-20: Pre-milking routine in Iringa. The control group refers to respondents interviewed in 1999 who had not attended the MTC, a video screening, or a group meeting (n=167). The '1999 group' refers to all other respondents interviewed in 1999 (n=88), whilst the '2000 group' refers to all respondents interviewed in 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Columns with different subscript letters showed significant differences

Responses associated with the recommended pre-milking practices of 'checking if the udder looked normal', 'checking if the udder felt normal', and 'checking the foremilk' were similar to those obtained in section 4.4.7, and showed evidence of effective dissemination in both 1999 (short-term), and 2000 (long-term). For all three facts, highly significant differences ($p<0.001$) were seen between the control group and 2000 respondents. In addition, highly significant differences ($p<0.001$) were also seen for 'checking if the udder felt normal' and 'checking if the milk looked normal' between the control group and 1999 respondents, and for 'checking if the udder looked normal' between 1999 and 2000 respondents. Thirty nine percent of control group respondents 'looked at the udder' prior to milking, compared to 48% of 1999 respondents, and 74% of 2000 respondents. Thirty two percent of control group respondents 'felt the udder' prior to milking, compared to 61% of 1999 respondents, and 71% of 2000 respondents. Fifty percent of control group respondents 'checked the milk' prior to milking, compared to 73% of 1999 respondents, and 81% of 2000 respondents (Fig 4-21).

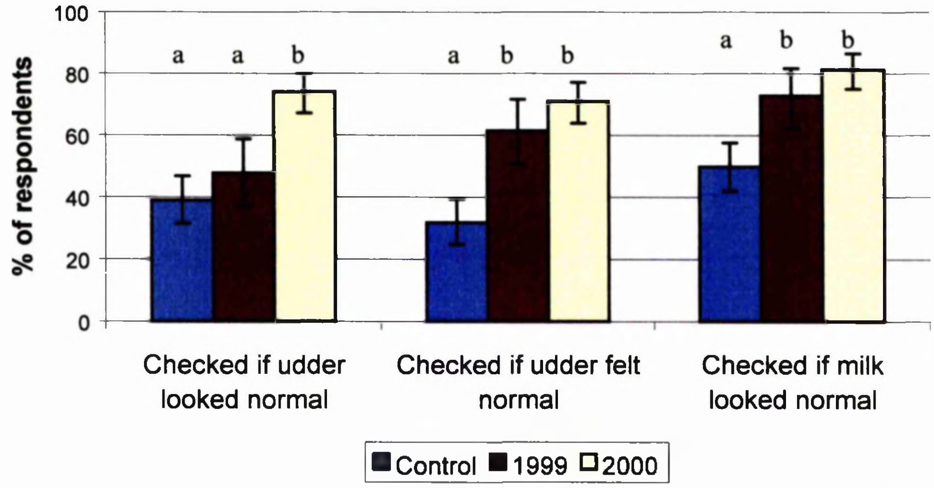


Figure 4-21: Methods of checking for mastitis in Iringa. The control group refers to respondents interviewed in 1999 who had not attended the MTC, a video screening, or a group meeting (n=167). The '1999 group' refers to all other respondents interviewed in 1999 (n=88), whilst the '2000 group' refers to all respondents interviewed in 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Columns with different subscript letters showed significant differences

4.4.8.2 Mastitis knowledge

Responses associated with the dissemination of facts concerning the 'effects of mastitis' showed marked differences with those in section 4.4.7, and showed evidence of effective dissemination in 1999 (short-term), often followed by a significant decrease in the number of respondents able to volunteer facts in 2000 (long-term). Knowledge about the possible 'effects of mastitis' was generally poor amongst the control group. Significant differences in proportions were seen for 'decreased yield (control-1999, $p<0.01$; control-2000, $p<0.05$) 'spread to other quarters' (control-1999, $p<0.01$; control-2000, $p<0.001$; 1999-2000, $p<0.05$), 'spread to other cows' (control-1999, $p<0.001$; control-2000, $p<0.01$; 1999-2000, $p<0.05$), 'decreased keeping quality' (control-1999, $p<0.001$; 1999-2000, $p<0.05$), 'milk may be rejected for sale' (control-1999, $p<0.01$; 1999-2000, $p<0.05$), 'risk of zoonotic disease' (control-1999, $p<0.01$; 1999-2000, $p<0.01$), 'decreased nutritional value' (control-1999, $p<0.001$; 1999-2000, $p<0.05$), and 'risk of death or culling of cow' (control-1999, $p<0.001$; control-2000, $p<0.001$). Two 'effects of mastitis' which showed marked increases in the number of respondents able to volunteer the facts following dissemination, included the 'risk of zoonotic disease' from drinking affected milk (control=32%, 1999=52%, 2000=35%), and the 'risk of death or culling for the cow' (control=33%, 1999=64%, 2000=52%) (Fig 4-22).

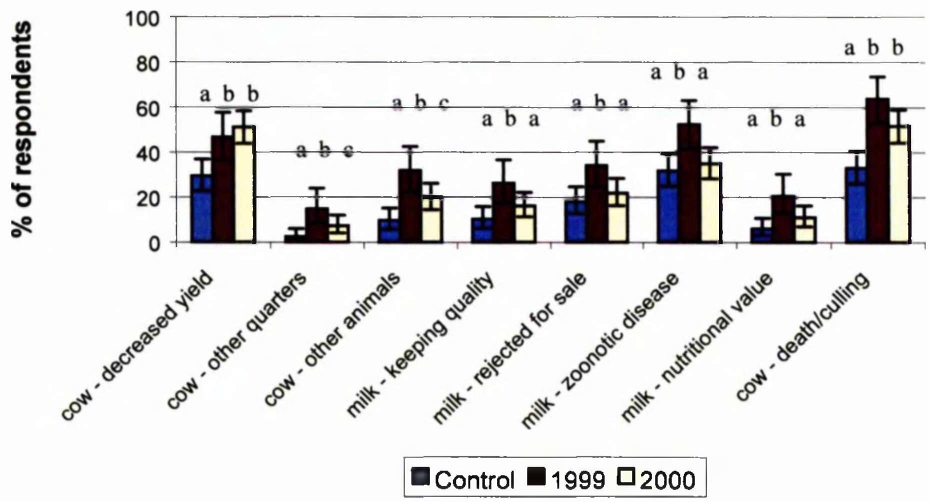


Figure 4-22: 'Effects of mastitis' volunteered by respondents in Iringa. The control group refers to respondents interviewed in 1999 who had not attended the MTC, a video screening, or a group meeting (n=167). The '1999 group' refers to all other respondents interviewed in 1999 (n=88), whilst the '2000 group' refers to all respondents interviewed in 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Columns with different subscript letters showed significant differences

Responses associated with dissemination of facts concerning 'signs of mastitis' were similar to those in section 4.4.7, and showed that dissemination was highly successful, with significant differences being seen for 'hot udder' (control-1999, $p<0.001$; control-2000, $p<0.001$), 'painful udder' (control-1999, $p<0.001$; control-2000, $p<0.001$), 'swollen udder' (control-1999, $p<0.05$, control-2000, $p<0.001$), 'discoloured udder' (control-1999, $p<0.01$; control-2000, $p<0.01$), 'clots or flakes in the milk' (control-1999, $p<0.01$; control-2000, $p<0.05$), and 'pus in the milk' (control-1999, $p<0.01$). The signs 'altered milk composition' and 'decreased milk yield' were actually volunteered by a slightly higher proportion of control group respondents, than by 1999 or 2000 respondents, however no significant difference was found between these proportions. In addition, there were no significant differences between the proportions of volunteered responses obtained for all other 'signs of mastitis' (Fig 4-23).

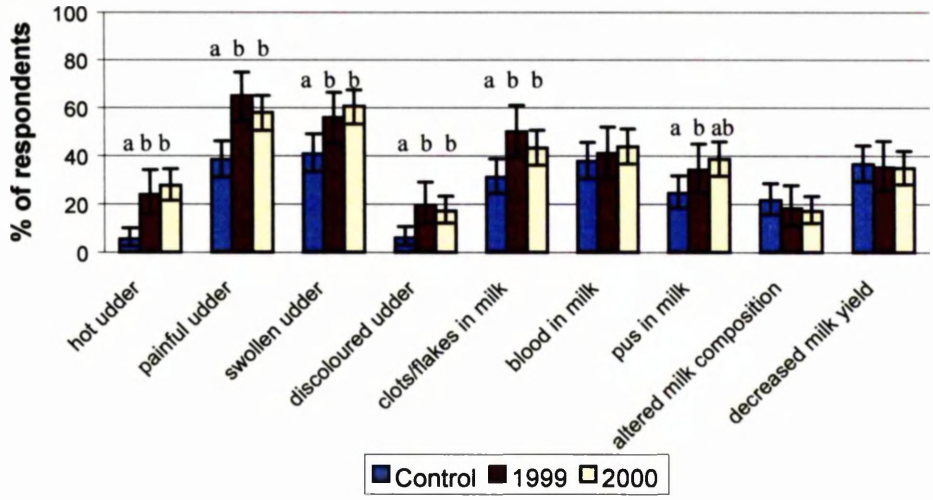


Figure 4-23: 'Signs of mastitis' volunteered by respondents in Iringa. The control group refers to respondents interviewed in 1999 who had not attended the MTC, a video screening, or a group meeting (n=167). The '1999 group' refers to all other respondents interviewed in 1999 (n=88), whilst the '2000 group' refers to all respondents interviewed in 2000 (n=192). The exact binomial 95% confidence intervals are shown for each response. Columns with different subscript letters showed significant differences

Responses associated with the dissemination of facts concerning the 'spread of mastitis' were similar to those obtained in section 4.4.7, and showed that dissemination had been extremely successful. A significant increase in the proportion of volunteered responses was seen following dissemination, between both control and 1999 respondents, and control and 2000 respondents. In general, there was a decrease in the proportions of volunteered answers between 1999 and 2000, however these were shown to be non-significant in all cases except for 'insect to cow'. Significant increases in the proportion of volunteered answers were seen for 'teat to teat' (control-1999, $p<0.001$; control-2000, $p<0.001$), 'cow to cow' (control-1999, $p<0.001$; control-2000, $p<0.001$), 'herd to herd' (control-1999, $p<0.001$; control-2000, $p<0.01$), 'insect to cow' (control-1999, $p<0.001$; control-2000, $p<0.05$; 1999-2000, $p<0.01$), 'dirty banda to cow' (control-1999, $p<0.001$; control-2000, $p<0.001$), 'milker's hands to cow' (control-1999, $p<0.001$; control-2000, $p<0.001$), and 'infected cloth to cow' (control-1999, $p<0.001$; control-2000, $p<0.01$). All other methods showed no significant differences between the proportions of volunteered answers (Fig 4-24).

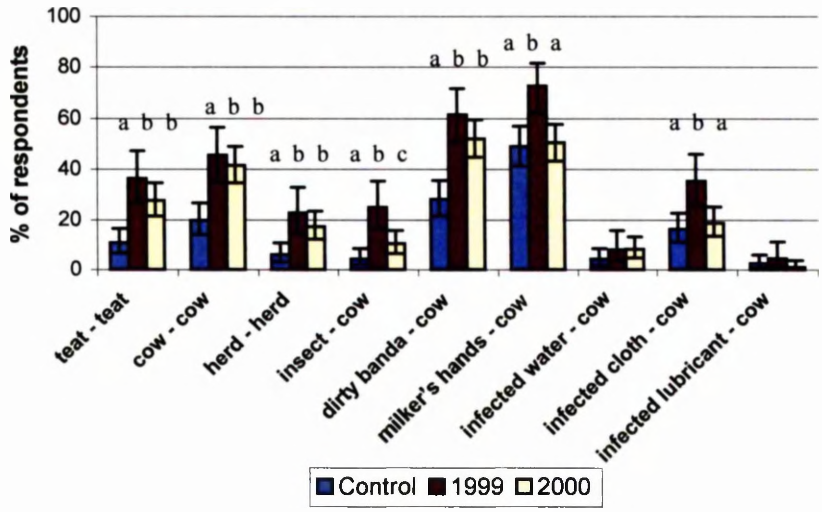


Figure 4-24: Methods of 'Spread of mastitis' volunteered by respondents in Iringa. The control group refers to respondents interviewed in 1999 who had not attended the MTC, a video screening, or a group meeting. The '1999 group' refers to all other respondents interviewed in 1999, whilst the '2000 group' refers to all respondents interviewed in 2000. The exact binomial 95% confidence intervals are shown for each response. Columns with different subscript letters showed significant differences

4.4.9 Statistical Modelling

Analysis was carried out using statistical models to investigate variables associated with respondents' mastitis knowledge in 1999 and 2000, as defined by 'volunteering mastitis facts post-dissemination'. Multi-level models were used, which assessed the contribution of individual question, farm, and village to the overall variation. The datasets were analysed separately, as, on a number of farms, different respondents had been interviewed in 1999 and 2000. An identical hierarchical design was used for both models, in order that comparisons could be drawn between the two final models. Individual question level (level 1) referred to an individual respondent being asked an individual question.

4.4.9.1 Multilevel Model 1 for 1999 data, with individual question, farm, and village as random effects

The contribution of each of the three levels, individual question, farm and village, calculated by the latent variable approach and binary linearisation model of estimating Intra-Class Correlation Coefficient (ICC), are shown in Table 4-5. Results show that over 90% of the variation was at the individual question level, with very little variation in knowledge between farms and villages. In the intercept only models there was a smaller amount of variation between villages, than between farms within villages, however a proportion of the variation at farm level, was subsequently accounted for by fixed terms in the final model.

Level	ICC (%) (latent variable approach)	ICC (%) (binary linearisation model)	ICC (%) (latent variable approach)
	Intercept only	*Intercept only*	*Including fixed effects* (Model 1)
Village	1.7	1.0	0.0
Farm	8.0	4.8	4.9
Individual question	90.3	94.2	95.1

Table 4-5: ICCs for model 1 (1999 data) calculated by the latent variable approach and the binary linearisation model. This model considered three levels of random effect, namely village, farm and individual question.

Univariable analysis

Univariable analysis for the outcome variable 'volunteering mastitis facts post-dissemination', using the 2nd order PQL method of estimation revealed a number of significant explanatory variables with a critical probability of 0.05, which are illustrated in Table 4-6. Significant positive associations were shown between the outcome variable 'volunteering mastitis facts post-dissemination' and a number of methods by which respondents stated they had learned about mastitis. The MTC showed a significant odds ratio of 3.28, whilst the video showed a significant odds ratio of 1.78, and other methods including the project poster, pen, EO, group meeting, and neighbour showed significant odds ratios of between 1.21 and 2.33.

A significant positive association, with an odds ratio of 2.03, was also demonstrated for respondents who had seen the project poster, and further significant associations were seen according to the locations in which project posters had been seen. A significant positive association was also seen for respondents who had seen the project diagrammatic handouts (OR=1.91), and for those who had been shown the diagrams by either their EO or FM. Respondents who had seen a project pen (OR=2.11) also showed a significant association with the outcome variable, in addition to those respondents who were able to remember the logo on the pen, and also those respondents who remembered seeing the same logo elsewhere, for example on a project t-shirt.

Significant negative associations were demonstrated with certain household roles, including 'daughter', 'cowboy' or 'relative' when compared to 'husband', and also when the respondent was responsible for 'cleaning the banda' or 'milking the cow'. In addition, when nine of the individual EO were compared to one reference individual, significant negative associations, with odds ratios ranging between 0.40 and 0.57, were seen for six of the EO. A significant negative association was also seen when the respondent was the second respondent (e.g. cowboy, or person responsible for cattle care) from that farm to be interviewed (Table 4-6).

Other variables had also been included in the original hypothesis concerning mastitis knowledge, however, following demonstration of non significant associations during univariable analysis, these were excluded from further analysis. Such village level variables included 'screening of a video in the village', and the 'VBAHW or FM responsible for the village'. Non significant farm level variables included 'incidence of mastitis on the farm prior to the cross-sectional study', 'incidence of mastitis on the farm during the study', and 'a CMT positive test on the farm during the study'. Respondent level variables which were shown to be non significant included 'a cowboy receiving mastitis training', 'learning about mastitis from an MTC attendant, video screening participant, VBAHW, or FM', 'seeing a poster at an agricultural input shop', and 'being shown the diagrammatic handout by a VBAHW'. Other variables which were also shown to be non significant on univariable analysis included 'the length of time that had elapsed since the MTC', and 'the length of time that had elapsed since the video screenings' (data not shown).

Fixed effects	*Coefficients*	*SE*	*OR*	*95% CI OR*	*p value*
Role in household					
-husband*			1.00		
-wife	-0.093	0.09	0.91	0.83, 1.00	0.301
-son	-0.427	0.22	0.65	0.52, 0.81	0.052
-daughter	-0.644	0.186	0.53	0.44, 0.63	0.001
-cowboy	-0.74	0.084	0.48	0.44, 0.52	<0.0001
-relative	-1.078	0.204	0.34	0.28, 0.42	<0.0001
-other	-0.215	0.203	0.81	0.66, 0.99	0.290
2nd Respondent on farm	-0.569	0.062	0.57	0.53, 0.60	<0.0001
Respondent cleans banda	-0.382	0.062	0.68	0.64, 0.73	<0.0001
Respondent milks cows	-0.371	0.062	0.69	0.65, 0.73	<0.0001
Learned about mastitis from MTC	1.188	0.102	3.28	2.96, 3.63	<0.0001
Learned about mastitis from video	0.576	0.085	1.78	1.63, 1.94	<0.0001
Learned about mastitis from poster	0.637	0.086	1.89	1.73, 2.06	<0.0001
Learned about mastitis from pen	0.844	0.083	2.33	2.14, 2.53	<0.0001
Learned about mastitis from EO	0.414	0.066	1.51	1.42, 1.62	<0.0001
Learned about mastitis from group meeting	0.412	0.087	1.51	1.38, 1.65	<0.0001
Learned about mastitis from neighbour	0.193	0.071	1.21	1.13, 1.30	0.0066
Seen poster	0.706	0.118	2.03	1.80, 2.28	<0.001
Seen poster at milk kiosk	0.451	0.115	1.57	1.40, 1.76	0.001
Seen poster at collection centre	0.547	0.141	1.73	1.50, 1.99	0.001
Seen poster at neighbour's house	0.372	0.067	1.45	1.36, 1.55	<0.0001
Seen poster at vet input shop	0.567	0.087	1.76	1.62, 1.92	<0.0001
Seen poster at VIC	0.769	0.138	2.16	1.88, 2.48	<0.0001
Seen diagrams	0.648	0.091	1.91	1.75, 2.09	<0.0001
Seen diagrams from EO	0.975	0.181	2.65	2.21, 3.18	<0.0001
Seen diagrams from FM	-0.709	0.262	0.49	0.38, 0.64	0.0068
Seen pen	0.745	0.094	2.11	1.92, 2.31	<0.0001
Remembered logo on pen	0.41	0.066	1.51	1.41, 1.61	<0.0001
Seen logo elsewhere	0.616	0.094	1.85	1.69, 2.03	<0.0001
EO for village					
-EO1*			1		
-EO2	-0.565	0.161	0.57	0.48, 0.67	0.0004
-EO3	-0.265	0.213	0.77	0.62, 0.95	0.2135
-EO4	-0.099	0.202	0.91	0.74, 1.11	0.6241
-EO5	-0.418	0.203	0.66	0.54, 0.81	0.0395
-EO6	-0.616	0.175	0.54	0.45, 0.64	0.0004
-EO7	-0.384	0.296	0.68	0.51, 0.92	0.1945
-EO8	-0.923	0.166	0.40	0.34, 0.47	<0.0001
-EO9	-0.626	0.157	0.54	0.46, 0.63	0.0001
-EO10	-0.586	0.211	0.56	0.45, 0.69	0.0055

Table 4-6: Model 1 univariable analysis for mastitis knowledge in Iringa in 1999. Reference categories for groups of dummy variables are marked by * in the table.

Multivariable analysis

A final multilevel model to describe the outcome variable 'volunteering mastitis facts post-dissemination' in 1999, was then fitted, with the random effects of village, farm and individual question taken into consideration, and allowing for residual confounding from other variables. Variables which were shown to be significant during univariable analysis were fitted into the final model adopting a backwards stepwise elimination procedure, and final estimation was done using a 2^{nd} order PQL estimation method.

The final multilevel model (Model 1) for mastitis knowledge in 1999 (Fig 4-25), defined by 'volunteering mastitis facts post-dissemination', with random effects of village, farm and individual question, included significant positive associations with the methods, 'MTC' (OR=2.25), 'video' (OR=1.28), 'pen' (OR=1.34), and 'EO' (OR=1.17) by which respondents stated they had learned about mastitis. In addition, there were significant positive associations with those 'respondents able to remember the logo on the project pen' (OR=1.29) and also with those 'respondents who had seen the logo elsewhere' (OR=1.26). Significant negative associations were seen when the respondent was a 'cowboy' (OR=0.83) or 'relative' (OR=0.59) of the householder, when compared to the 'husband' of the household. In addition, significant negative associations were also seen with three of the individual EO ('EO 7', 'EO 8' and 'EO 10'), who showed odds ratios of 0.57, 0.71 and 0.56 respectively, when compared to the reference EO 1, who was widely considered to be one of the best in the area (Table 4-7).

$$\left.\begin{array}{l}\text{outcome}_{indqu,farm,village} \sim \text{Binomial}(\text{denom}_{indqu,farm,village}, \pi_{indqu,farm,village}) \\ \text{outcome}_{indqu,farm,village} = \pi_{indqu,farm,village} + e_{0indqu,farm,village}\text{cons}^{*}\end{array}\right\}$$

$$\begin{aligned}\text{logit}(\pi_{indqu,farm,village}) = {} & \beta_{1farm,village}\text{bcons} + -0.180(0.142)\text{eo2}_{village} + -0.022(0.185)\text{eo3}_{village} + \\ & -0.193(0.179)\text{eo4}_{village} + -0.104(0.182)\text{eo5}_{village} + -0.062(0.155)\text{eo6}_{village} + \\ & -0.561(0.254)\text{eo7}_{village} + -0.343(0.150)\text{eo8}_{village} + -0.243(0.143)\text{eo9}_{village} + \\ & -0.572(0.187)\text{eo10}_{village} + 0.092(0.087)\text{wife}_{indqu,farm,village} + \\ & -0.143(0.199)\text{son}_{indqu,farm,village} + -0.256(0.171)\text{daughter}_{indqu,farm,village} + \\ & -0.188(0.095)\text{cowboy}_{indqu,farm,village} + -0.520(0.215)\text{relative}_{indqu,farm,village} + \\ & -0.035(0.190)\text{other}_{indqu,farm,village} + 0.812(0.110)\text{mtc}_{indqu,farm,village} + \\ & 0.248(0.085)\text{video}_{indqu,farm,village} + 0.291(0.100)\text{pen}_{indqu,farm,village} + \\ & 0.160(0.071)\text{eo}_{indqu,farm,village} + 0.255(0.066)\text{logopen}_{indqu,farm,village} + \\ & 0.228(0.095)\text{logoelse}_{indqu,farm,village}\end{aligned}$$

$$\beta_{1farm,village} = -1.502(0.152) + v_{1village} + u_{1farm,village}$$

$$\left[v_{1village}\right] \sim \text{N}(0,\ \Omega_v) \ : \ \Omega_v = \left[0.000(0.000)\right]$$

$$\left[u_{1farm,village}\right] \sim \text{N}(0,\ \Omega_u) \ : \ \Omega_u = \left[0.169(0.026)\right]$$

$$\text{cons}^{*} = \text{cons}[\pi_{indqu,farm,village}(1 - \pi_{indqu,farm,village})/\text{denom}_{indqu,farm,village}]^{0.5}$$

$$\left[e_{0indqu,farm,village}\right] \sim (0,\ \Omega_e) \ : \ \Omega_e = \left[1.000(0.000)\right]$$

Figure 4-25: Final multilevel Model 1 for variables associated with mastitis knowledge in Iringa in 1999, defined by 'volunteering mastitis facts post-dissemination'. Random effects considered in this model are village, farm and individual question.

Regression terms	Estimates	SE	OR	95% CI OR	p value
Random effects	*Variance estimate*				
Village	0.000	0.000			
Farm	0.169	0.026			
Individual question	1	0			
Fixed effects	*Coefficients*				
Learned about mastitis from MTC	0.812	0.11	2.25	2.02, 2.51	0.0000
Learned about mastitis from video	0.248	0.085	1.28	1.18, 1.40	0.0035
Learned about mastitis from pen	0.291	0.1	1.34	1.21, 1.48	0.0036
Learned about mastitis from EO	0.16	0.071	1.17	1.09, 1.26	0.0242
Respondent remembered logo on pen	0.255	0.066	1.29	1.21, 1.38	0.0001
Respondent remembered seeing logo elsewhere	0.228	0.095	1.26	1.14, 1.38	0.0164
Role in household					
-Husband*			1.00		
-Wife	0.092	0.087	1.10	1.01, 1.20	0.2903
-Son	-0.143	0.199	0.87	0.71, 1.06	0.4724
-Daughter	-0.256	0.171	0.77	0.65, 0.92	0.1344
-Cowboy	-0.188	0.095	0.83	0.75, 0.91	0.0478
-Relative	-0.52	0.215	0.59	0.48, 0.74	0.0156
-Other	-0.035	0.19	0.97	0.80, 1.17	0.8538
EO for village					
-EO1*	0	0	1.00		
-EO2	-0.18	0.142	0.84	0.72, 0.96	0.2049
-EO3	-0.022	0.185	0.98	0.81, 1.18	0.9053
-EO4	-0.193	0.179	0.82	0.69, 0.99	0.2809
-EO5	-0.104	0.182	0.90	0.75, 1.08	0.5677
-EO6	-0.062	0.155	0.94	0.80, 1.10	0.6892
-EO7	-0.561	0.254	0.57	0.44, 0.74	0.0272
-EO8	-0.343	0.15	0.71	0.61, 0.82	0.0222
-EO9	-0.243	0.143	0.78	0.68, 0.90	0.0893
-EO10	-0.572	0.187	0.56	0.47,0.68	0.0022

Table 4-7: Final multilevel Model 1 for explanatory variables associated with mastitis knowledge in Iringa in 1999, defined by 'volunteering mastitis facts post-dissemination'. Random effects considered in this model are village, farm and individual question. Where applicable, an entire group of associated dummy variables are shown, with the reference category marked by * in the table.

4.4.9.2 Multilevel Model 2 for 2000 data, with individual question, farm, and village as random effects

A multilevel model was also used to analyse responses from respondents in 2000. The contribution of each of the three levels, individual question, farm and village, calculated by the latent variable approach and binary linearisation model of estimating Intra-Class Correlation Coefficient (ICC), are shown in Table 4-8. Results show that almost 90% of the variation was at the individual question level, with very little variation in knowledge between farms and villages. In the intercept only models there was a smaller amount of variation between villages, than between farms within villages, however a large proportion of the variation at farm level, was subsequently accounted for by fixed terms in the final model (Model 2).

Level	ICC (%) (latent variable approach)	ICC (%) (binary linearisation model)	ICC (%) (latent variable approach)
	Intercept only	*Intercept only*	*Including fixed effects* (Model 2)
Village	0.4	0.5	0.3
Farm	9.7	5.5	1.7
Individual question	89.9	94.0	98.1

Table 4-8: ICCs for model 2 (2000 data) calculated by the latent variable approach and the binary linearisation model. This model considered three levels of random effect, namely village, farm and individual question.

Univariable analysis

Univariable analysis for the outcome variable 'volunteering mastitis facts post-dissemination', using the 2nd order PQL method of estimation revealed a number of significant explanatory variables with a critical probability of 0.05, which are illustrated in Table 4-9. Significant positive associations were shown between the outcome variable 'volunteering mastitis facts post-dissemination' and a number of methods by which respondents stated they had learned about mastitis. The MTC showed a significant odds ratio of 2.05, whilst the video showed a significant odds ratio of 1.52, and other methods including the project visits, newsletter, poster, pen, EO, VBAHW, FM, group meeting, and neighbour showed significant odds ratios of between 1.27 and 2.24.

A significant odds ratio of 2.15 was also seen for respondents who had seen the project poster, and further significant associations were seen according to the places in which respondents had seen project posters. A significant association was also seen for respondents who had seen the project diagrammatic handouts (OR=1.57), and for those who had been shown the diagrams by either the EO or the FM. Respondents who had seen a project pen (OR=2.45) also showed a significant association with the outcome variable, in addition to those respondents who were able to remember the logo on the pen, and also those respondents who remembered seeing the same logo elsewhere, for example on a project t-shirt. Significant positive associations were also seen when 'the cowboy had received training', and 'the respondent had been interviewed in 1999'.

Significant negative associations were demonstrated with certain household roles, including 'son', 'daughter', 'cowboy' or 'relative' when compared to 'husband', when the 'cowboy had changed since the 1999 visit', and also when the respondent was responsible for 'cleaning the banda' or 'milking the cow'. In addition, when nine of the individual EO were compared to one reference individual, significant negative associations, with odds ratios of 0.61 and 0.68, were seen for two of the EO. A significant negative association was also seen when the respondent was the second person (e.g. cowboy or relative responsible for care of the cows) to be interviewed on the farm and when the attendant on the farm had changed between 1999 and 2000 (Table 4-9).

Other village, farm and respondent level variables had also been included in the original hypothesis concerning mastitis knowledge, however, following demonstration of a non significant association during univariable analysis, they were excluded from further analysis. Such village level variables included 'screening of a video in the village', whilst farm level variables included 'incidence of mastitis on the farm prior to the cross-sectional study', 'incidence of mastitis on the farm during the study', and 'a CMT positive test on the farm during the study'. Respondent level variables which were shown to be non significant included 'whether the respondent had been interviewed in 1999', 'learning about mastitis from an MTC attendant, video screening participant, or cowboy training session', 'having the poster displayed in the house' 'seeing a poster at a milk kiosk, or milk collection centre', and 'being shown the diagrammatic handout by an EO, VBAHW, or FM'. Other variables which were also shown to be non significant during univariable analysis included, 'the length of time elapsed since the MTC', 'the length of time elapsed since the video screenings', and 'the identity of the interviewer' (data not shown).

Fixed effects	*Coefficients*	*SE*	*OR*	*95% CI OR*	*p value*
Attendant received training about mastitis	0.243	0.110	1.28	1.14, 1.42	0.027
Attendant changed since 1999 visit	-0.357	0.112	0.70	0.63, 0.78	0.001
Role in household					
-husband*			1.00		
-wife	-0.206	0.11	0.81	0.73, 0.91	0.061
-son	-0.531	0.212	0.59	0.48, 0.73	0.012
-daughter	-0.698	0.236	0.50	0.39, 0.63	0.003
-cowboy	-0.717	0.103	0.49	0.44, 0.54	0.000
-relative	-0.973	0.331	0.38	0.27, 0.53	0.003
-other	-0.26	0.333	0.77	0.55, 1.08	0.435
Respondent interviewed in 1999	0.615	0.084	1.85	1.70, 2.01	<0.0001
2nd Respondent on farm	-0.333	0.119	0.72	0.64, 0.81	0.0051
Respondent cleans banda	-0.283	0.084	0.75	0.69, 0.82	0.0008
Respondent milks cows	-0.32	0.082	0.73	0.67, 0.79	0.0001
Learned about mastitis from MTC	0.718	0.126	2.05	1.81, 2.33	<0.0001
Learned about mastitis from video	0.417	0.102	1.52	1.37, 1.68	<0.0001
Learned about mastitis from project visits	0.415	0.122	1.51	1.34, 1.71	0.0007
Learned about mastitis from poster	0.803	0.156	2.23	1.91, 2.61	<0.0001
Learned about mastitis from pen	0.806	0.095	2.24	2.04, 2.46	<0.0001
Learned about mastitis from newsletter	0.259	0.088	1.30	1.19, 1.41	0.0032
Learned about mastitis from EO	0.604	0.083	1.83	1.68, 1.99	<0.0001
Learned about mastitis from VBAHW	0.279	0.111	1.32	1.18, 1,48	0.0120
Learned about mastitis from FM	0.240	0.114	1.27	1.13, 1.42	0.0353
Learned about mastitis from group meeting	0.441	0.09	1.55	1.42, 1.70	<0.0001
Learned about mastitis from neighbour	0.369	0.083	1.45	1.33, 1.57	<0.0001
Seen poster	0.766	0.195	2.15	1.77, 2.61	<0.001
Seen poster at neighbour's house	0.444	0.094	1.56	1.42, 1.71	<0.0001
Seen poster at vet input shop	0.352	0.100	1.42	1.29, 1.57	0.0004
Seen poster at agricultural input shop	0.384	0.181	1.47	1.23, 1.76	0.0339
Seen poster at VIC	0.49	0.153	1.63	1.40, 1.90	0.0014
Seen diagrams	0.449	0.126	1.57	1.38, 1.78	0.0004
Seen pen	0.897	0.097	2.45	2.23, 2.70	<0.0001
Remembered logo on pen	0.346	0.081	1.41	1.30, 1.53	<0.0001
Seen logo elsewhere	0.493	0.091	1.64	1.49, 1.79	<0.0001
EO for village					
-EO1*			1		
-EO2	-0.137	0.194	0.87	0.72, 1.06	0.4801
-EO3	0.04	0.245	1.04	0.81, 1.33	0.8703
-EO4	-0.007	0.259	0.99	0.77, 1.29	0.9784
-EO5	-0.412	0.236	0.66	0.52, 0.84	0.0809
-EO6	-0.488	0.214	0.61	0.50,0.76	0.0226
-EO7	-0.018	0.31	0.98	0.72, 1,34	0.9537
-EO8	-0.241	0.209	0.79	0.64, 0.97	0.2489
-EO9	-0.381	0.188	0.68	0.57, 0.82	0.0427
-EO10	-0.058	0.252	0.94	0.73, 1.21	0.8180

Table 4-9: Model 2 univariable analysis for mastitis knowledge in Iringa in 2000. Reference categories for groups of dummy variables are marked by * in the table.

Multivariable analysis

A final multilevel model to describe the outcome variable 'volunteering mastitis facts post-dissemination' in 2000, was then fitted, with the random effects of village, farm and individual question taken into consideration, and allowing for residual confounding from other variables. Variables which were shown to be significant during univariable analysis were fitted into the final model adopting a backwards stepwise elimination procedure, and final estimation was done using a 2nd order PQL estimation method.

The final multilevel model (Model 2) for mastitis knowledge in 2000 (Fig 4-26), defined by 'volunteering mastitis facts post-dissemination' in 2000, with random effects of village, farm and individual question, included significant positive associations with the methods, 'MTC' (OR=1.57), and 'EO' (OR=1.26) by which respondents stated they had learned about mastitis. In addition, there were significant positive associations with those respondents who were able to remember the logo on the project pen (OR=1.30) and also with those respondents who had seen the logo elsewhere (OR=1.24). Negative associations were seen with one of the individual EO (EO 9), who showed a significant odds ratio of 0.75 when compared to the reference EO (Table 4-10).

$$
\left.\begin{aligned}
&\mathrm{outcome}_{indivqu,farm,village} \sim \mathrm{Binomial}(\mathrm{denom}_{indivqu,farm,village}, \pi_{indivqu,farm,village}) \\
&\mathrm{outcome}_{indivqu,farm,village} = \pi_{indivqu,farm,village} + e_{0indivqu,farm,village}\mathrm{cons}^{*}
\end{aligned}\right\}
$$

$$
\begin{aligned}
\mathrm{logit}(\pi_{indivqu,farm,village}) = {} & \beta_{1farm,village}\mathrm{bcons} + 0.135(0.149)\mathrm{eo2}_{village} + -0.127(0.171)\mathrm{eo3}_{village} + \\
& 0.154(0.179)\mathrm{eo4}_{village} + -0.174(0.169)\mathrm{eo5}_{village} + -0.120(0.177)\mathrm{eo6}_{village} + \\
& -0.057(0.205)\mathrm{eo7}_{village} + 0.094(0.164)\mathrm{eo8}_{village} + -0.282(0.137)\mathrm{eo9}_{village} + \\
& -0.091(0.172)\mathrm{eo10}_{village} + 0.452(0.093)\mathrm{mtc}_{indivqu,farm,village} + \\
& 0.229(0.080)\mathrm{eo}_{indivqu,farm,village} + 0.262(0.075)\mathrm{logopen}_{indivqu,farm,village} + \\
& 0.217(0.069)\mathrm{logoelse}_{indivqu,farm,village}
\end{aligned}
$$

$$\beta_{1farm,village} = -1.195(0.121) + v_{1village} + u_{1farm,village}$$

$$\left[v_{1village}\right] \sim \mathrm{N}(0,\ \Omega_v) \ :\ \Omega_v = \left[0.009(0.010)\right]$$

$$\left[u_{1farm,village}\right] \sim \mathrm{N}(0,\ \Omega_u) \ :\ \Omega_u = \left[0.056(0.018)\right]$$

$$\mathrm{cons}^{*} = \mathrm{cons}[\pi_{indivqu,farm,village}(1 - \pi_{indivqu,farm,village})/\mathrm{denom}_{indivqu,farm,village}]^{0.5}$$

$$\left[e_{0indivqu,farm,village}\right] \sim (0,\ \Omega_e) \ :\ \Omega_e = \left[1.000(0.000)\right]$$

Figure 4-26: Final multi-level Model 2 for variables associated with mastitis knowledge in Iringa in 2000, defined by 'volunteering a correct mastitis fact post-dissemination'. Random effects considered in this model are question type, question number and individual question.

Regression terms	*Estimates*	*SE*	*OR*	*95% CI OR*	*p value*
Random effects	*Variance estimate*				
Village	0.009	0.010			
Farm	0.056	0.018			
Individual question	1	0			
Fixed effects	*Coefficients*				
Learned about mastitis from MTC	0.452	0.093	1.57	1.43	<0.0001
Learned about mastitis from EO	0.229	0.08	1.26	1.16	0.0042
Respondent remembered logo on pen	0.262	0.075	1.30	1.21	0.0005
Respondents remembered seeing logo elsewhere	0.217	0.069	1.24	1.16	0.0017
EO for village					
-EO1*			1.00		
-EO2	0.135	0.149	1.14	0.99, 1.33	0.3649
-EO3	-0.127	0.171	0.88	0.74, 1.04	0.4577
-EO4	0.154	0.179	1.17	0.98, 1.40	0.3896
-EO5	-0.174	0.169	0.84	0.71, 1.00	0.3032
-EO6	-0.12	0.177	0.89	0.74,1.06	0.4978
-EO7	-0.057	0.205	0.94	0.77, 1.16	0.7810
-EO8	0.094	0.164	1.10	0.93, 1.29	0.5665
-EO9	-0.282	0.137	0.75	0.66, 0.87	0.0396
-EO10	-0.091	0.172	0.91	0.77, 1.08	0.5968

Table 4-10: Final multilevel Model 2 for explanatory variables associated with mastitis knowledge in Iringa in 2000, defined by 'volunteering mastitis facts post-dissemination'. Random effects considered in this model are question type, question number and individual question. Where applicable, an entire group of associated dummy variables are shown, with the reference category marked by * in the table.

4.5 Discussion

This phase of the study aimed 1) to review current milking and milk preparation practices in order to identify target populations and target issues for dissemination in the future, 2) to discuss attitudes and experiences of mastitis with EO, VBAHW and FM, 3) to identify EO's existing methods of treatment for mastitis, 4) to implement knowledge dissemination about mastitis to smallholder dairy farming communities in Iringa using the dissemination materials previously developed by the project (Chapter 3), 5) to evaluate the effectiveness of knowledge dissemination undertaken by the project both in the short-term (one month) and long-term (sixteen months) 6) to assess whether knowledge dissemination about mastitis resulted in changes in actual behaviour in relation to banda hygiene and milking practices.

It was hypothesised that direct dissemination of information by the project to a proportion of the community via a residential MTC and video screenings would facilitate further, indirect, dissemination within the community via social networks, and methods such as informal discussion and group meetings, and observation of project dissemination materials including poster, pens and diagrammatic handouts. In addition, the author hypothesised that previous experience of a clinical case of mastitis by a respondent would be likely to be associated with an increased level of mastitis knowledge.

4.5.1 Major findings

The first aim of this phase of the study was achieved, with one of the major descriptive findings of the study being the fact that cowboys were responsible for cleaning the banda on 68% of farms, and for milking on 59% of farms, and thus potentially had the most direct influence over the incidence of mastitis on the farm. In addition, results of the multilevel modelling (Model 1) showed that the odds of a cowboy (OR=0.83) 'volunteering a correct mastitis fact' were significantly less than those of a husband. This suggests that, where applicable, cowboys should be targeted by mastitis dissemination programmes, in preference to smallholder farmers or other members of their households. Results of this study, however, also showed that a number of factors hindered the dissemination of information to cowboys, including a high turnover rate of cowboys on farms, busy schedules precluding them from attending training sessions, the intentional restriction of their access to new knowledge by the owner, and social and cultural influences which resulted in the head of a household attending training courses in preference to the most appropriate member of the household. Poor levels of literacy were also common amongst cowboys, with 12% of the cowboys interviewed for the study being illiterate, and many more likely to be only semi-literate, although this fact was not evaluated by the study. These findings, therefore, have implications concerning the most appropriate methods of knowledge dissemination for use with cowboys, and suggest that, where possible, verbal, visual or diagrammatic methods should be employed.

Results of this study also showed that the wife of the household was often responsible for supervision of dairy activities, which suggests that generally wives should also be targeted by mastitis dissemination programmes.

This phase of the study also aimed to discuss attitudes towards mastitis, and experiences of the disease with EO, VBAHW and FM, and to identify EO's existing methods of treatment for mastitis. These aims were achieved during the participatory group discussions undertaken during the MTC. Results provided an overview of previous experiences of mastitis on smallholder farms in Iringa, in addition to an overview of the existing level of knowledge about the disease, which was shown to often be extremely limited, and the existing standard of treatment provided by EO, which was shown to often be sub-optimal.

One of the main aims of this phase of the study was to facilitate dissemination of mastitis knowledge to communities of smallholder farmers in Iringa via both direct, and indirect, methods of dissemination. Results showed this was achieved, with the overall level of mastitis knowledge amongst the study population increasing between 1999 and 2000. A further major aim of the study was to develop appropriate, and acceptable, dissemination materials for use on smallholder farms, and results of this study show that this was also achieved. In addition, evaluation of the effectiveness of different dissemination methods, which incorporated project dissemination materials, was also achieved, with the MTC, video screenings, EO and pen shown to have a positive association with mastitis knowledge in the short-term, whilst the MTC and EO had a positive association with mastitis knowledge in the long-term. One major finding of the study was that the success of dissemination differed between individual facts.

Results of direct observation of the banda and milking equipment suggest that despite an overall increase in mastitis knowledge amongst project respondents, there was no actual change in behaviour, a finding that concurs with those of other studies (Mitchell et al., 2001; Torabi et al., 2000; Harvey et al., 2000), but contradicts those of other studies which found that a change in knowledge also lead to a change in behaviour (Yuan et al., 2000; Windsor et al., 2000; O'Donnell et al., 1998). Mitchell (2001) suggests that knowledge alone is inadequate in modifying behaviour. It should, however, be acknowledged that this study only intended to evaluate the effectiveness of different methods of dissemination for increasing knowledge about mastitis, and not their effectiveness for changing actual behaviour. Dissemination of knowledge may, however, be seen as a first step towards changing actual behaviour, and the adoption of recommended practices, and it is hoped that the results of this study may therefore provide a basis for further research into this subject. It has been reported by extension workers that direct verbal interactions lead to the most changes in farming behaviour (Garforth and Usher, 1997).

Results of this study also showed that there was often major discrepancy between respondents' stated practices concerning milking and banda hygiene, and the actual practices carried out. The production of 'fake cloths and teat lubricant' by a number of respondents suggests that they were likely to have 'volunteered the recommended practice', even if they did not actually perform such a practice. It was also suspected that respondents volunteered what they thought were 'correct practices', a finding which concurs with the findings of Linney (1995) that suggest that 'respondents often seem to give replies that they think the interviewer wants to hear'. The fact that respondents volunteered such practices suggests that they did, at least, possess knowledge about the recommended practices, but that no reliable inferences concerning the actual on-farm practices can be made.

In 1999, descriptive results showed that the 'MTC' and 'video' were the most commonly volunteered routes by which respondents perceived they had learned most about mastitis, however in 2000 the most commonly volunteered routes were 'project visits' and the 'project poster'. This suggests that the MTC and video were perceived by respondents as being important routes of knowledge dissemination in the short-term, however perception of their importance then decreased over time. In contrast, the perceived importance of monthly 'project visits' increased over time, which may be accounted for by respondents increased contact with, and acceptance of, the project PhD colleague, whose monthly visits enabled respondents to ask questions, or clarify points about mastitis on a regular, informal basis. The visits themselves are likely to have also acted to remind, and reinforce, concepts about mastitis, and should be taken into account when considering the overall success of dissemination of mastitis knowledge within the project area. Results of multilevel modelling, however, suggest that those methods that respondents perceived to be important sources of mastitis knowledge in the long-term, actually showed no significant association with mastitis knowledge, and their ability to 'volunteer mastitis facts post-dissemination'.

Results of multilevel modelling showed that methods of dissemination that had an actual significant positive association with mastitis knowledge in 1999, one month after dissemination (short-term effect), were the MTC (OR=2.25), video screenings (OR=1.28), project pen (OR=1.34) and the EO (OR=1.17). In contrast, in 2000, sixteen months after dissemination (long-term effect), the only methods of dissemination that were shown to have a significant positive association with mastitis knowledge were the MTC (OR=1.57) and the EO (OR=1.26). This suggests that the impact of the video screenings and the pen on knowledge dissemination diminished over time. Nuthall (1999) states that "learning is a matter of the cumulative effects of experience", and that "successive representations of a fact are integrated with each other and progressively change the knowledge base with which further representations are interpreted". Studies have shown that an initial representation of a fact may be stored in the working memory for two days, after which time it may be lost, unless further associated representations are experienced (Nuthall, 1999), however, other studies have also shown that the nature and duration of a working memory may be specific to a particular knowledge domain, and may also be influenced by development of expertise in that domain (Ericsson and Kintsch, 1995 cited by Nuthall, 1999; Rovee-Collier, 1995 cited by Nuthall, 1999). It is, therefore, proposed by some authors that an individual must be exposed to a representation of a fact on three or four separate occasions, within the period of two days, in order that a permanent representation of a fact be constructed and transferred to the long-term memory (Nuthall and Alton-Lee 1993, cited by Nuthall 1999). In this case, it may be hypothesised that the MTC had a significant effect on long-term mastitis knowledge as it provided concepts about mastitis facts on at least three separate occasions within a period of two days, for example clinical signs of mastitis were included in lectures, group discussions, and the practical class. In contrast, the video screenings were likely to have only provided concepts about such facts on one occasion, and unless further exposure, such as discussion with neighbours, was experienced in the two days following the screening, the concepts are unlikely to have been transferred to the long-term memory. Video has been used successfully by a number of other projects for the dissemination of information, however most of these have involved evaluation of knowledge post-intervention at periods of between two weeks to two months (Tender et al., 2001; Yuan et al., 2000; Torabi et al., 2000). Research concerning the long-term effectiveness of video as a dissemination method is scarce, however one medical study into HIV/AIDS used a follow-up period of seventeen months, and showed that a video intervention was effective in changing behaviour throughout this period (O'Donnell et al., 1998).

Descriptive results of this study suggested that some EO had made little effort to organise group meetings to disseminate information from the MTC, however, results of the multilevel modelling showed that there was a significant positive association between a respondent stating that 'they had learned about mastitis from their EO' and the respondent 'volunteering a correct mastitis fact', both in the 1999, and 2000. This suggests that EO were an important source of information to smallholder farmers, a finding which concurs with the views of other studies (Subedi and Garforth, 1996; Dulle and Aina, 1999), but which conflicts with other studies in which it was found that farmers were more likely to obtain information from, and exchange ideas with, other farmers in preference to extension staff (Garforth and Usher, 1997). Results of this study did, however, also show that there were significant differences between the impact of individual EO on mastitis knowledge. Model 1 showed that there was a significant negative association between EO7, EO8 and EO10 and mastitis knowledge in 1999 when compared to EO1, whilst the same was true for EO9 in 2000. The negative association seen in 2000 with EO9 may be attributable to the fact that this person had moved away from the Iringa region in early 2000, and had been replaced by a different EO, who had not attended the MTC. The negative associations seen for the three EO in 1999 may, however, be due to differences in their individual characters, and their motivation to further disseminate information to farmers within their villages. It may, therefore, be concluded that, whilst EO are appropriate targets for detailed training courses such as the MTC, and the associated financial investment in training each EO is worthwhile, care should be taken to select appropriate individuals for training. The format used in this project workshop was considered to be appropriate for EO, as it allowed dissemination of detailed information about mastitis, combined with the development of action plans and recommendations for treatment of cases that were appropriate for farms in their area. This is important as it has been shown by other studies that the main factor influencing the uptake of extension messages by farmers is the relevance or appropriateness of the message to their own lives (Garforth and Usher, 1997).

In contrast, the investment made by the study in training VBAHW and FM by the MTC format was not considered to be worthwhile, as results of this study demonstrated that they showed no significant impact on mastitis knowledge of the project population, a finding which conflicts with that of other studies (Gurung 1992, cited by Subedi and Garforth, 1996; Subedi et al 1990, cited by Subedi and Garforth 1996). One of the main aims of the

MTC was to educate a small number of VBAHW and FM about mastitis, in order that they could then disseminate the information further at village level, thus it was extremely disappointing that a number of participants, particularly in urban areas, made no effort to further disseminate this information at all. Such individuals were often from areas where organised Farmer Groups did not exist, and they were therefore leaders, or 'convenient representatives' of the area, rather than FM elected by fellow farmers. The failure to further disseminate information may have resulted from inadequate emphasis of this matter by project PIs during the MTC, however, results also showed that the extent of further dissemination undertaken varied widely according to the individual. This also suggests that in the future, selection of participants for training workshops should be carefully considered, a recommendation which concurs with other authors (Mitchell et al., 2001; Muhammad and Garforth, 1998). It has been shown that the selection of 'community educators' for propagation of information may be inappropriate, and ineffective, as one study showed that they served as a source of information to only 2.6% of fellow farmers (Muhammad and Garforth, 1998). Selection of community educators by Governments, projects or extension staff has often been based on a number of factors including high social status, education level, age (with elderly individuals being preferred), economic ability, co-operation with field staff, and approachability (Muhammad and Garforth, 1998; Mitchell et al., 2001). One study showed, however, that fellow farmers preferred community educators who were progressive, of ordinary social status, young or middle-aged, and of moderate education level (Muhammad and Garforth, 1998). The same study found that selection of elderly individuals of high social status as Ces was inappropriate due to their tendency to be occupied in political activities, their lack of approachability, and inflexibility towards progressive methods (Muhammad and Garforth, 1998). It was also found that access to community educators was not equal amongst villagers, and that the educated, and rich members of the community, tended to be avoided, in addition to older relatives of the community educator (Mitchell et al., 2001). It has also been found that the opinions of some community educators, who were already familiar to villagers, were undervalued as villagers could not appreciate how they had 'suddenly become an expert on a subject' (Mitchell et al., 2001). A further study in Nepal showed that gender had an influence on the extent to which inter-farmer communication processes occurred. Male farmers were shown to have homogenous (male to male) patterns of communication amongst each other, whilst female farmers were shown to be active seekers of information with both homogenous (female to female) patterns of communication, and heterogenous (female to male) communication patterns (Subedi and Garforth, 1996). The same study concluded, however, that information was more likely to flow among males than females, as males had more communication networks, due to their ability to interact in village meeting places, or travel distances to communicate with other male farmers, whilst females were often responsible for the majority of household chores which led to constraints on the time available for interaction with other farmers (Subedi and Garforth, 1996). Gender has also been shown to have a strong influence over exposure of individuals to formal sources of information (Subedi and Garforth, 1996). Male respondents in Nepal were shown to have significantly higher levels of contact with extension workers, district extension agencies, research centres, printed extension materials, and access to radio broadcasts when compared to female respondents (Subedi and Garforth, 1996), a trend which was also found to be true during this study.

Informal farmer-to-farmer interaction is considered to be an important process which results in effective diffusion of innovations (Rogers, 1983, cited by Subedi and Garforth, 1996; Antholt, 1991, cited by Subedi and Garforth, 1996; Alders et al 1993, cited by Subedi and Garforth 1996). In addition, other studies have shown that neighbours, friends and relatives are important sources of farm information (Muhammed 1994, cited by Subedi and Garforth, 1996; Ramkumar 1995, cited by Subedi and Garforth 1996). Whilst results of this study show that dissemination of mastitis knowledge did occur throughout the study population, it is possible that some of the communication pathways responsible for this were not evaluated by the project. In addition, multilevel models showed that dissemination by neighbours, friends and other sources did not have a significant association with overall mastitis knowledge.

A further concern, resulting from the findings of the study, was the high attrition rate of MTC participants encountered within sixteen months of the training. In many cases this was due to unavoidable reasons such as relocation or death, however, the resulting loss of a trained individual from the study area had major implications for further dissemination to smallholder farmers, and this also added to concerns about the high cost incurred for training each MTC participant. Further evaluation of the cost-effectiveness of dissemination methods such as residential mastitis training courses, and village video screenings would be of benefit.

Results showed that EO had a significant positive impact on mastitis knowledge in the study population, which may lead to the hypothesis that the MTC was successful in disseminating knowledge about mastitis to EO themselves, which then enabled them to successfully disseminate the information to smallholder farmers. Firm conclusions cannot, however, be drawn concerning this matter, as the mastitis knowledge of individual EO following the MTC was not assessed by the project, for reasons stated previously. With hindsight, however, this exercise should have been undertaken, in order to evaluate the efficacy of the MTC format as an education method for extension workers. In addition, it would have been useful to establish the level of knowledge being disseminated to smallholder farmers by EO, as it is recognised information is not simply passed from one person to another, but that communication leads to the continual transformation and adaptation of information (Garforth and Usher, 1997).

This study showed that knowledge dissemination of recommended farm practices concerning milking routine, and of mastitis facts varied, both in terms of the degree of success, and the length of time over which dissemination was successful. Over 90% of the variance within the multilevel models was attributable to the individual question level, suggesting that certain questions were answered better than others, and that certain facts were therefore disseminated better than others. A small amount of variance was also seen at farm level, of which, only a proportion was accounted for by fixed terms within the model, suggesting that some sources of farm level variation in the model were not measured, or recorded, by the project. Dissemination of certain facts proved to be extremely successful, including 'using one corner of the cloth to dry each teat', which was a novel recommendation devised by the project, and showed evidence of effective short-term, and long-term, dissemination. The recommendation to 'dry each teat with one corner of the cloth' was devised by the project as an economically viable, easily implemented and acceptable recommendation to farmers, and this fact was discussed during the MTC and was also vividly illustrated during the Tanzanian video. In addition, many farmers appeared to be interested by the recommendation at the time of dissemination, and also discussed the method subsequently during the project PhD colleague's farm visits. It was extremely encouraging that dissemination of this fact was so successful, and perhaps owes success to the affordability and ease of adopting the method, and the relevance of the fact to local farmers, as it has been shown by other studies that the main factor influencing the uptake of extension messages by farmers is the relevance or appropriateness of the message to their own lives (Garforth and Usher, 1997).

In contrast, dissemination of other facts such as 'washing only the teat, not the whole udder', and 'drying the udder using a hand, rather than a cloth' were not successful. These recommendations caused controversy at the time of dissemination, as farmers generally believed that it was better to 'wash the whole udder, rather than the teats', and also better to 'use a cloth to dry the udder, rather than removing excess water by hand and allowing the udder to dry naturally'. Despite full verbal explanations for the reasons behind both of these recommendations, it may have been difficult to change farmers pre-existing, firmly held, beliefs. Visual images, either on the video or during the MTC practical class, of 'water dripping down the udder to rest at the end of the teat', and 'dirty cloths being used to dry an udder' might perhaps have been more successful in explaining these facts, and convincing farmers that these practices could lead to an increase in disease. It has been shown by studies into the use of multimedia as education methods, that learners understand explanations better when they receive both verbal, and corresponding visual, information about a fact, rather than just verbal information alone, and understanding is further increased if the verbal and visual information is presented at the same time (Mayer, 1999). In addition, villagers in one study in Botswana stated that certain kinds of information could only be disseminated satisfactorily by practical demonstrations (Byram and Garforth, 1980).

Dissemination of the three key recommended facts concerning 'checking for mastitis prior to milking' was extremely successful, with all three facts, 'looking at the udder', 'feeling the udder' and 'checking the milk', showing evidence of both successful short-term and long-term dissemination. This was extremely encouraging, as these three recommendations formed the major part of the project's 'key basic advice' to farmers, in which the udder, and milk of each cow should be thoroughly checked for abnormalities on a daily basis. It was hoped that if such practices were followed, they would enable early and efficient detection of mastitis cases, which would increase the chance of a successful outcome following treatment, and decrease the risk of spreading the disease further. These points were reiterated at regular intervals during the MTC, and were also strongly emphasised during the Tanzanian video, factors which may both have accounted for the successful dissemination of these points (Nuthall, 1999).

The project pen had been seen by over 97% of respondents in 1999, however, only 50% were able to remember the logo on the pen, and by 2000 this proportion had decreased to 23% of respondents. Results of multilevel modelling for mastitis knowledge in both 1999 and 2000 showed, however, that there were significant positive associations between a respondent 'remembering the logo on the pen', or 'having seen the project logo elsewhere', and them 'volunteering a correct mastitis fact'. This may suggest that the project logo had a positive impact on mastitis knowledge, perhaps by stimulating thought or discussion about mastitis. An alternative explanation, however, may be that respondents who were able to recognise and remember the project logo, were perhaps more likely to have a 'good memory' for remembering facts, or to have received higher levels of education than other respondents (a variable which was not measured by the project), both of which may have influenced their mastitis knowledge. Descriptive results also showed that long-term exposure to the logo was successful, as 43% of respondents in 2000 had seen the logo on other materials such as project t-shirts and recording forms, compared to only 15% of respondents in 1999. The use of advertising logos has not been commonplace in Tanzania until recent years, and is currently mainly limited to posters, newspaper, radio and TV advertising. Urban farmers may thus have been exposed to the concept of logos, however, it is unlikely that this has been the case for the majority of their rural colleagues. Published research concerning the effect of logos on the uptake of knowledge is scarce, however one study stated that 't-shirts increased the visibility of the programme in the community and helped to foster increased communication regarding the subject of interest' (Klepp et al., 1997).

It was also interesting that results showed that previous exposure of a respondent to a mastitis case on their farm had no significant association with mastitis knowledge. This was contrary to the proposed hypothesis of the study, and suggested that respondents did not learn about mastitis through direct exposure to the disease, nor did exposure to the disease stimulate them to learn more about the subject.

Results also showed that there was no association between a 'respondent being interviewed in 1999', and their ability to 'volunteer a correct mastitis fact in 2000'. It has been suggested that awareness of being observed by a study, in addition to the act of administering a questionnaire to a respondent, a phenomenon termed the Hawthorne effect (Garforth personal communication 1999), may lead to higher levels of comprehension of a subject (Byram and Garforth, 1980), however results suggest that this was not the case in this study. An additional alternative hypothesis may also be proposed in which administration of the questionnaire did lead to a short-term increase in comprehension about the subject, but that this comprehension had faded by the time of questionnaire administration in 2000. Firm conclusions about the phenomenon of the Hawthorne effect cannot be drawn from the results of this part of the study, and further research on this important area of research is required.

Studies with schoolchildren in New Zealand have shown that differences in learning outcomes are related to their interaction and participation in classroom activities (Nuthall, 1999). In addition, individual differences in learning outcomes are often attributed to inherent differences in both the academic ability of a respondent, and their background knowledge of a subject (Nuthall, 1999). This part of the study did not evaluate the background knowledge, or individual learning ability of respondents, nor did it record their interactions during the process of dissemination, thus conclusions cannot be drawn about the effect of these factors on respondents' ability to learn about mastitis. Background knowledge, individual learning ability, and the interaction of respondents during dissemination may, therefore, have contributed to some of the variation, which was not accounted for by fixed terms, within the models.

It was recognised that by restricting the sampling frame of farmers to those within 45km of Iringa town, the sample may not have represented smallholder farmers in extremely rural communities, who were also likely to have had decreased access to education compared to those farmers residing nearer to the main town.

4.5.2 Mastitis Training Programme

The rate set for the daily allowance for EO (10,000 Tsh per day) and VBAHW and FM (5,000 Tsh per day) attending the MTC was based on local government recommendations, and figures from previous workshops run by other NGOs in the area. This amount, however, was felt by project PIs to be excessively generous, and resulted in the MTC being an extremely expensive exercise (2,850,000 Tsh), with the cost per participant calculated to be 67,857 Tsh. As the budget for the MTC was fixed, it was felt that training of an increased number of participants would have been preferable, and would also have been possible, had the generous daily allowances not been provided. Discussion with SHDDP colleagues, however, revealed that the precedent set by previous workshops, and government guidelines, had resulted in an expectation by Iringa residents that they would receive an allowance when attending a meeting or workshop in town, and failure to provide such allowances would result in poor levels of attendance. Before instigating an alternative approach, in which participants were asked to contribute to the cost of their education, it would, therefore, be necessary to re-educate people about such issues, in order to reach a point where the motivation for attendance at a workshop was based on the desire to increase knowledge, rather than for financial gain.

The dissemination materials used during the workshop were well accepted, and generally well understood by farmers, although the 'arrow diagram' format of the poster and diagrammatic handout needed brief explanation initially, a finding which concurs with that of other authors (Linney, 1995; Harford and Baird, 1997).

Results of this study concerning the project poster showed that the majority of respondents had seen the project poster, and that popular places for it to be seen, other than a farmer's own house, were neighbours houses and veterinary input shops. This suggests that the project poster had achieved the project goal of being seen by a large number of people within the study area, thereby raising overall awareness of the project, and awareness of mastitis as a disease of dairy cattle. It should, however, be noted that there was discrepancy between the number of respondents who stated that they had seen the poster, and the number who stated that it had actually been a source of mastitis knowledge. This suggests that whilst the vast majority of people had seen the poster, not all had read, or understood it, and this was particularly true in 2000, when a long period of time had elapsed since distribution of the poster. It is possible that the poster contained an excess of information, as other authors have suggested that the most effective posters have clear, uncomplicated pictures and short, written messages (Harford and Baird, 1997). A further explanation may be that respondents' perception of the importance of the poster as a source of mastitis knowledge had decreased over time, and that other sources of knowledge, which may have been experienced more recently, may have been perceived to be more important.

The poor use of the mastitis diagrams for subsequent dissemination by MTC participants may have been caused by a failure of project PIs to adequately emphasise this intention during the MTC, and this may have been a particular problem with VBAHW and FM, as time was extremely short at the end of their workshop. It had been hoped that the diagrams would provide a visual template around which further mastitis trainings could be conducted, and for this reason the EO diagrams were laminated in order to make them weatherproof and improve their durability. It may, however, have been that MTC participants who did organise further mastitis trainings, devised their own timetable for the training using their own methods of dissemination. One fact noted by project PIs was that many people in Tanzania, particularly middle-aged men, were keen to be involved in public speaking, and were often extremely confident, and inclined to speak for long periods of time, when invited to do so. In addition, the majority of training in the past in Tanzania has been conducted mainly by didactic methods such as lectures, and this may therefore be the method chosen by many Tanzanians to further disseminate information, rather than the use of more visual, or participatory methods. In addition, participatory methodology (see Chapter 2) is relatively new, and has only been used by SHDDP since 1996, thus most farmers may still be accustomed to the more traditional, didactic methods of knowledge dissemination.

The participative group discussion concerning EO experience and treatment of mastitis revealed that all EO were familiar with the disease. A number of interesting points were raised concerning existing treatment regimes, including the fact that all EO infused parenteral antibiotics into affected quarters via re-sterilised intramammary tubes, a practice which project PIs subsequently advised against. One major positive outcome of the MTC may thus be the cessation of such a treatment regime by EO in the study area. The MTC also disseminated knowledge concerning the most appropriate choice of antibiotics for mastitis treatment under different circumstances. The inclusion of such information in 'action plans' devised by EO illustrated that this information had been understood and absorbed.

Group discussion with VBAHW and FM revealed that a number of participants were unfamiliar with mastitis, whilst those that were, had only limited knowledge of the disease. It was apparent that all farmers contacted their EO in the first instance if they identified mastitis in their cow, which reinforces the view that it was perhaps appropriate that EO received intensive training about the disease, whilst VBAHW, FM and key farmers could perhaps have sufficed with basic training about hygienic milking practices, and methods of identification and prevention of mastitis.

The action plans devised during the MTC illustrated that key points had been understood and absorbed by participants, and then assimilated and used to form feasible and acceptable recommendations for mastitis in their area. Action plans also proved to be a useful method of summarising key points about mastitis at the end of the MTC.

This study showed that knowledge dissemination about milking routine and mastitis facts varied, both in terms of the degree of success, and the length of time over which dissemination was successful.

4.6 Future recommendations

For future projects involving dissemination of mastitis knowledge, it would be beneficial to identify the person responsible for the main dairy activities, and supervision of these activities on each farm, and then target these individuals personally for dissemination. It would also be advisable to have separate sessions for those responsible for the dairy activities, and those responsible for supervision, as it was a common observation during fieldwork for this study that cowboys were intimidated by the presence of their employees, as were some wives, sons and daughters by the presence of their father or husband.

In contrast to participants being paid to attend a training course, future exercises may consider charging participants a nominal fee for attendance, whilst reimbursing travel and accommodation costs to participants from distant rural areas. Such a system is operated by TDDP for attendance at their residential training course, which is compulsory for farmers prior to obtaining an HIT or TWIT cow (see Chapter 5). Payment of a small fee for attendance at a training course may encourage participants to attend the course in full, and feel that they have invested in their education, in contrast to the system used by this, and many other projects which in hindsight may have been seen as a 'money making' opportunity by some delegates, particularly those from urban areas.

In addition, a beneficial strategy may be to advertise the training course to the whole village, with a request that they elect their most suitable representative to attend the course. In this way, the rest of the village would also be aware that the training course was taking place, and would then be more likely to exert pressure on the course attendant to disseminate their knowledge upon their return to the village. A further option that should perhaps be considered, and is recommended by Linney (1995), would be to conduct smaller, more concise workshops within each village, in order that the majority of farmers are able to attend in person. Although this method has implications for both time and expense, it may result in effective dissemination of important knowledge to a greater number of farmers.

For future projects, it may be advantageous to plan a video screening timetable at least two weeks in advance, in order that suitable screening times could be allocated for particular villages or areas. This would also allow time for suitable advertisement of the screening, through a combination of verbal invitations, written invitations, public notices or even local radio. One EO in this study did, however, feel that it was important that screenings were not advertised too far in advance, as villagers may forget, or lose interest in attending. The same EO also thought that it was important to advertise the fact that the video screening would be free of charge to participants, as other video screenings in Tanzania e.g. of music video or feature films, often incur an attendance fee.

It would have been advisable to arrange the meeting with selected farmers prior to the video screening in a separate venue nearby. During most of the video screening meetings, other participants entered the venue throughout the course of the informal discussion, which resulted in some interruption, and possible intimidation of some farmers to respond freely. It would also have been an advantage to have such a meeting in a small room, which would allow an informal grouping arrangement of participants e.g. in a circle, or U-shape, rather than in rows (Leggat, 2000).

It was noted that the 'zero-grazing' video included some humorous scenes with a 'village idiot' type farmer, to convey messages about the subject. These were extremely popular with the audience, and comments were made that it was an effective way of imparting information. This should, therefore, be taken into consideration during production of future videos. In addition, the exercise asking participants to 'spot the mistakes' in the video, proved to be a useful test as to whether participants had learned from the recommendations stated earlier in the video. It also helped to provide a useful summary of key points at the end of the screening.

An evening screening using a mobile video unit at an outdoor venue would be the preferred choice for video screenings. This would allow most of a village to attend at a convenient time of day. Mass attendance by a village would also make the screening into a 'village event', which would hopefully stimulate discussion about the subject for some time afterwards. Such a timetable would however, necessitate that only one village per day could be visited, which would lead to implications concerning time and expense for the project.

A skilled co-facilitator, capable of stimulating discussion in a friendly and approachable manner, was essential to the success of the screenings, and the discussions surrounding them. It was also important that the EO for the village attended the screening, as they would be the person dealing with future cases of mastitis, and future enquiries about mastitis. It was therefore important to emphasise to video screening participants that they should seek the advice of the EO if they suspected a mastitis problem, and also that the EO would be able to give them further education about the disease (e.g. in the form of a group meeting) should they request it. Garforth (1985) also commented that the effective use of media in the field requires that extension staff be able to reinforce, explain and demonstrate ideas communicated by the media.

Some of the suggestions for further dissemination proposed by respondents were of interest. There is increasing interest in the use of mass media and communications technology for knowledge dissemination (Garforth, 1985; Leggat, 2000), although research on multimedia learning is at an early stage (Mayer, 1999). Radio is gaining increasing interest as a method of dissemination, due to the relative affordability, ease of access, and ability to broadcast locally relevant material to a large audience (Garforth, 1985; Subedi and Garforth, 1996). It has also been suggested that radio should be used to promote farmer to farmer communication (Garforth, 1997). It is also recognised that whilst the use of electronic communications and mass media, such as community based television sets, computerised databases, the internet, and other satellite based technology would be extremely useful in rural areas of developing countries (Garforth, 1997), their use will probably be restricted to urban areas which have the infrastructure to use and maintain such equipment (Garforth and Usher, 1997). The use of choir as a dissemination method is an interesting concept, with much to recommend it, as the church is an extremely important part of many peoples lives in Tanzania (Bell, personal observation, 1999), and in addition, a number of religious organisations, for example the Catholic Church in the Philippines, are already involved in projects in developing countries (Garforth, 1985).

5 DIRECT KNOWLEDGE DISSEMINATION TO A DEFINED NUMBER OF SMALLHOLDER DAIRY FARMERS IN TANGA

5.1 Introduction

General features of both smallholder dairying in Tanzania, and knowledge dissemination are described in previous chapters. This aspect of the study was carried out in Tanga between May and July 2001, in close collaboration with the Tanga Dairy Development Project (TDDP), a Dutch NGO based in Tanga.

5.1.1 Study site

The Tanga region is situated in the north-eastern coastal area of Tanzania, along the Indian ocean, and experiences a hot, humid, tropical climate. The region covers approximately 26,800 km^2, divided into six districts, Tanga, Muheza, Korogwe, Pangani, Lushoto and Handeni. The region lies between latitudes 04° and 06° South of the equator, and longitudes 37° and 39°10' East of Greenwich, and consists of a variety of landforms, ranging from flat, rolling terrain in the coastal strip, to mountainous regions in the Usambaras which reach 2400m above sea level. The area comprises nine agro-ecological zones, and can also be subdivided into areas of low, medium and high potential for dairying. Rainfall in the region also varies, with the warm tropical coastal region receiving 1200 to 1400mm rainfall per year, whilst areas further inland such as Handeni receive only 850mm per year. Rainfall also tends to increase with altitude, and may reach 1500 to 2000mm per year in the Usambara Mountains. Two distinct rainy seasons are seen in the region, Masika (March to May) and Vuli (October to December) (TDDP, 1996).

The last national census in 1988 estimated the population of the area to be approximately 1.3 million people, however assuming a 2.9% increase per year (Bureau of Statistics, 1991), this could now be estimated at 1.9 million people.

5.1.2 Livestock

The cattle population of the Tanga region is estimated to be approximately 650,000, of which approximately 10,500 belong to smallholder farmers (Bureau of Statistics, 1996). Veterinary care for animals in the study area is provided mainly by EO, and a small number of private veterinary surgeons, as described in Chapter One.

5.1.3 History of TDDP

Dutch development aid to the livestock sector followed the large scale parastatal approach between 1975 and 1985, however as this approach produced disappointing results, a smallholder approach was then instigated, supported by both Tanzanian Government and Dutch development aid (TDDP, 1999a). The Livestock Training Institute (LITI) Buhuri was supported to train smallholder farmers, whilst the Mruazi/Magunga Heifer Breeding Unit was supported to provide good quality crossbred heifers. The Smallholder Dairy Extension Project (SDEP) was started in 1985 to provide services to dairy farmers, recruit new dairy farmers, and develop and promote dairy technologies appropriate to the Tanga region. The Heifer in Trust (HIT) scheme was started in 1989 following the realisation that resource poor farmers were unable to produce the cash, or obtain a loan, required to purchase a heifer (TDDP, 1999a). The Two Weaners in Trust (TWIT) scheme was introduced in 1996 as an alternative credit scheme, aimed at allowing farmers to repay their credit more quickly. An initial down payment of 50,000 Tsh, was required for this scheme, which also involved an extended period until milk production by the heifer was achieved. As the project developed, it was decided that cattle would also be sold to those people in a financial position to afford them (TDDP, 1999a). The SDEP, HIT and training schemes were combined in 1991 to form the Tanga Smallholder Dairy Development Programme (TSDDP). The five main objectives of the TSDDP scheme were to train farmers how to manage a dairy unit; provide on farm extension; provide farmers with high quality dairy heifers; ensure the availability of veterinary supplies; and to develop a viable milk marketing strategy. The programme then grew into an integrated dairy sector approach, dealing with all levels of operation that linked the producer to the final consumer, including milk production, extension, training, veterinary services, input supplies, AI, milk collection, milk processing and milk marketing. The project therefore supported the development of the private sector in order that these services could be provided, and that a sustainable dairy infrastructure could be achieved (TDDP, 1999a).

In recent years the project has changed it's name to the Tanga Dairy Development Project(TDDP), the goal of which is to improve the living conditions of Tanga inhabitants by increasing, and strengthening, the dairy sector (TDDP, 1999a). The three major objectives of the program are:

1. To expand dairy production through the provision and addition of good quality cattle, establishment of new dairy farmers and improvement of farming practices through training, extension and monitoring.
2. To strengthen and expand the dairy infrastructure.
3. To find ways to reduce risks and improve the efficiency of dairy farms (TDDP, 1999a).

As Tanga region has few employment opportunities, the establishment of a smallholder farm is therefore an important opportunity to generate income for villagers (TDDP, 1999a). Cows can transform products such as grasses and crop residues, with little nutritional or economic value, into valuable and useful products such as meat, milk and manure (TDDP, 1999a). In addition, cow manure and urine are valuable products for maintaining soil fertility (TDDP, 1996), and may actually be considered a 'cash crop' in certain areas. The economic importance of smallholder dairy farming is also recognised, as milk provides a regular source of income, and animals can also be culled, or sold, to solve a financial crisis (TDDP, 1999a).

Gender issues are important considerations to the TDDP schemes, and they justify the fact that there is a higher number of female contract holders than male is justified by the average division of labour on the farm (TDDP, 1996). It is also recognised that as the EO is the person in regular contact with farmers, it is important that the EO is sensitive to gender issues in order to reach and support female farmers (TDDP, 1996).

TDDP 'polices' their HIT and TWIT schemes to a high level, and confiscate donated animals if they feel that farmers are not reaching an acceptable level of husbandry. Records show that, on average, approximately 1% of animals are withdrawn from farmers due to poor management (TDDP, 1996).

The TDDP scheme contains 2700 dairy farmers, who report regularly to the project, and are included in their data monitoring system. In addition, a further 1000 farmers have dairy cattle, but are classified as 'non reporting' and are not included in the TDDP data monitoring system (TDDP, 1999a). Since the beginning of the dairy programme in Tanga, almost 2400 farmers have started dairying through the credit schemes, 44% of which were women, and 36% of these farmers had repaid their credits (TDDP, 1999a).

The heifer breeding activities of the project are contracted out to two heifer breeding units, Mkwaja and Mzeri Ranch. The policy of the programme is to produce high quality crossbred heifers with less than 75% exotic genes, a process which initially begins with the insemination of Boran mother stock with imported Friesian semen (TDDP, 1999a). During the period 1996 to 1999, Tanga farmers received 697 of such Boran Friesian heifers via the TDDP credit schemes, and a further 150 through private sales. In addition, 448 pregnant heifers from the HIT scheme were redistributed from one smallholder farmer to another (TDDP, 1999a). TDDP has also supported artificial insemination (AI) in urban areas, in order to produce improved breeding bulls which can subsequently be distributed in rural areas where AI is not feasible. Approximately 95 of these bulls were sold to rural areas for a subsidised price between 1996 and 1999 (TDDP, 1999a).

Liti Buhuri is a livestock training institute developed as a project since 1977 jointly by the Tanzanian government and Dutch government, and funded by the Dutch government (TDDP, 1996). The institute provides a basic farmers training course, which comprises a two week residential program, during which time farmers are taught the basic skills required for keeping dairy cattle under a smallholder situation. Such skills include hand milking, pasture management, and recognition of common diseases of dairy cattle. The course comprises a series of lectures, in addition to practical classes involving the resident herd of dairy cattle maintained by the institute. Course participants also receive a comprehensive handout covering pertinent aspects of dairy cattle keeping (TDDP, 1996). There is usually only one course place available per household, and, following discussion with the rest of the household, the most suitable candidate is often selected by the EO. The institute trained 654 farmers between 1996 and 1999, of which 30% were women. The cost per trainee was 64,000 Tsh, of which the farmer had to contribute approximately 10,000 Tsh (TDDP, 1999a).

The extension service in Tanga region is provided by 40 EO, who are employed by the Government in the first instance. TDDP provides a top up salary and fuel allowance in order to facilitate the EO to assist new farmers in setting up their farms, monitor outstanding credit animals, provide veterinary assistance and advise farmers on ways of improving the management of their farm. In 1999 the ratio of EO to farmers was 1:68, a ratio which had increased from 1996 when the ratio was 1:60 (TDDP, 1999a). Prior to

1996, extension services tended to follow an individual farm visit approach, which proved to be effective but expensive. A group approach was therefore instigated, in which farmers were encouraged to form their own groups in order to share their knowledge, for example concerning feeding and pasture management. In addition, EO visit the groups and impart knowledge or problem solve with the group, either by organising field days about specific subjects, or by organising exchange visits between farms to demonstrate different management methods. The cost of extension has been calculated to equate to approximately 10 Tsh per litre of milk produced (TDDP, 1999a).

5.2 Aims

The aim of this phase of the study was to evaluate, and quantify, the effectiveness of different combinations of methods for the direct dissemination of mastitis knowledge to a defined number (n=280) of smallholder farmers. Mastitis knowledge was evaluated over a short-term (2 week) period.

5.3 Materials and Methods

5.3.1 Study design

The design of the study was based on a three level cluster design in which random selection of farmers, dissemination method, and village was performed from an original sampling frame. This sampling frame included all villages containing ten or more farmers within the TDDP database. The cluster design was blocked according to village type classification, namely urban, peri-urban or rural, and twelve villages from each block were then randomly selected, resulting in selection of a total of 36 villages. Within each block, the six combinations of dissemination methods, namely 'village meeting', 'village meeting and video', 'village meeting and handout', 'village meeting, video and handout', 'handout', or 'control' methods were randomly assigned in order that each combination of methods was assigned to two villages. A target figure of seven farmers per village was obtained by power calculations, however, the piloting exercise revealed that a number of unforeseen circumstances, particularly ill health of respondents, prevented post- dissemination visits from being undertaken. Ten farmers per village were therefore randomly selected in an effort to ensure that a total of seven farmers per village, interviewed both pre-, and post-dissemination, could subsequently be included in data analysis of the study results.

It was also decided, subsequent to initial sampling, to make a preliminary study of the 'Hawthorne effect', and thus, where possible, a further seven farmers were randomly selected from villages which had been assigned the 'Control' method. This was possible in four of the six villages assigned the 'Control' method, however there were insufficient farmers in the two remaining villages to allow this.

5.3.2 Dissemination materials and methods

Dissemination materials used for this phase of the study were the same as those described previously, which had been initially developed for use in Iringa. These materials included a video filmed and produced by the project team, a diagrammatic handout with annotation, and diagrammatic posters. These materials were used to form five possible combinations of dissemination methods, namely 'village meeting', 'village meeting and video', 'village meeting and handout', 'village meeting, video and handout', or 'handout' methods. Video was not used as an individual method due to the practical difficulties of showing a video to an individual farmer. An outline was drawn up for the village meetings in order to maintain consistency of content and use of teaching aids in every village. An additional method included in the study was that of a 'Control' group in which the respondents received no training whatsoever, but received visits for questionnaire administration at the same interval as those respondents in dissemination groups. The aim of the 'Control' group was to provide a baseline reference group against which dissemination methods could be compared. In addition, a 'Hawthorne control' group was also included in the study, as it had been hypothesised that the act of administering a pre-dissemination questionnaire could itself affect the subsequent mastitis knowledge of respondents. Thus, the 'Hawthorne control' group received only a post- dissemination visit and questionnaire.

On farms where a cowboy was responsible for tending and milking the cows, it was recognised that such individuals were likely to be the more appropriate target of dissemination about mastitis, however, this was felt to be inappropriate on cultural and political grounds, and householders were therefore targetted for this part of the study.

5.3.3 Study protocol

The study was undertaken over a period of nine weeks, divided into three blocks of three weeks. Twelve villages were visited during each block, with the initial visit and dissemination being undertaken during week one, and the post dissemination visit being undertaken during weeks two and three. This ensured that a consistent, and appropriate, period of time of between one and two weeks was left between dissemination and evaluation of knowledge by questionnaire. Respondents were asked questions concerning six main areas of mastitis, namely 'identification', 'action taken', 'signs', 'effects', 'spread', and 'prevention' of mastitis

5.3.3.1 Preparation

All farmers were sent letters of introduction from the project team, which included an invitation to attend a 'training' concerning aspects of animal disease. During the recruitment of farmers to the study, every effort was made to use the term 'animal disease' rather than 'mastitis' as it was felt that this could bias results concerning farmers' knowledge about mastitis. EO were then asked to notify farmers of the appropriate venue and time of the training within two days of the event. Where a village meeting formed part of the dissemination method, an appropriate venue was selected with the aid of the EO, and was often a school or a village meeting hall. Where 'Control' or 'handout' methods were used, the respondent was visited individually, where possible at their own farm, or alternatively at a convenient location e.g. their place of employment.

5.3.3.2 Pre- dissemination questionnaire

Immediately following group introductions, the respondents were given the pre-dissemination questionnaire to complete. In villages where a village meeting formed part of the dissemination method it was found during the pilot exercise that time constraints made it impossible to administer the pre dissemination questionnaire by personal interview to all ten respondents. It was found that this process could take up to two hours, and fellow respondents were unwilling to wait for this length of time until the start of the meeting. It was decided, therefore, to give respondents the questionnaire to complete themselves, with a co-facilitator reading each question out to the group, and elaborating any points that needed clarification. Sufficient time was allowed for respondents to write down their responses before moving on to the next question. Those respondents who were illiterate, or had poor eyesight, were given a scribe to assist them to write their responses. Respondents were encouraged not to discuss the questions or responses amongst themselves. The exercise lasted, on average, approximately half an hour. As the pre-dissemination questionnaire (Appendix 16) comprised open-ended questions relating to mastitis e.g.

'What signs do you associate with mastitis', all responses were recorded as 'volunteered' answers.

5.3.3.3 Dissemination phase

Following administration of the pre-dissemination questionnaire, mastitis training was given using one of the five combinations of dissemination methods previously described. Where a group meeting formed part of the dissemination method, respondents were encouraged to ask questions and discuss points as a group throughout the training. Each respondent was given a soda at the end of the meeting, which on average lasted one and a half hours. An appointment was then arranged for revisiting the village to administer a post-dissemination questionnaire individually to each farmer. Respondents in the 'Control' group did not receive any form of dissemination during the first visit, however, as a goodwill gesture, it was felt to be important to provide training of some form to all study participants. These respondents, in addition to those in the 'Hawthorne control' group were, therefore, given a diagrammatic handout at the end of the second visit, following administration of the post-dissemination questionnaire.

5.3.3.4 Post- dissemination questionnaire

A period of two weeks between dissemination and evaluation was selected following consultation with relevant literature, and experts in the field (Nuthall, 1999; Torabi, 2000; Garforth, personal communication, 2000). The second visit was therefore carried out two weeks after the dissemination phase, and during this time the post-dissemination questionnaire (Appendix 17) was administered by personal interview. The questions asked at this time were identical to those in the pre-dissemination questionnaire, however, an increased range of responses was recorded. Initially, open questions were asked e.g. 'What signs do you associate with mastitis?' and respondents were allowed to volunteer as many responses as they were able. Once respondents indicated that they had no further responses to volunteer, the interviewer moved on to the next question. In this manner, all questions on the questionnaire were asked in an open manner, and all volunteered responses were recorded. Once this process had been completed, however, the interviewer then returned to the start of the questionnaire and administered the questions in a closed manner e.g. 'Is a hot udder a sign of mastitis?'. Respondents were able to respond 'yes' (recorded as 'prompted' answers), 'no' or 'unsure' to these questions, and all responses were recorded. A number of incorrect mastitis facts e.g. 'Is coughing a sign of mastitis?' were included in the post-dissemination questionnaire as 'validation variables', in order to establish whether respondents were simply answering 'yes' to all prompted facts presented to them. The post-dissemination questionnaire took, on average, forty minutes to complete.

5.3.4 Data Analysis

5.3.4.1 Data storage and analysis

Collected data were entered into Epi Info databases (Coulombier et al., 2001), and this software was used to quantify mastitis knowledge and respondent, farm, village and question level variables. Comparison of two or more proportions, to see if they were significantly different, was done using Chi squared tests in the Epi Info 6 Epitable programme (Coulombier et al., 2001). The Yates corrected p-value was used, except when one or more of the expected cell values were less than 5, when the Fisher exact test p-value was used. A critical probability of $p=0.05$ was used throughout the study.

5.3.4.2 All responses: post- dissemination

All responses obtained post dissemination were subdivided into 'volunteered', 'prompted', 'no' or 'unsure' categories. Volunteered responses were those where the respondent volunteered the fact of interest in response to the initial open question e.g. "What are the signs of mastitis?" to which the response was "a hot udder, clots in the milk etc.". Prompted responses were those in which the respondent volunteered the fact of interest after prompting e.g. "Is a hot udder a sign of mastitis?" to which the response was "yes". Similarly, "no" and "unsure" responses were obtained after prompting e.g. "Is a hot udder a sign of mastitis?" to which the response was either "no" or "unsure". A Chi squared test was used to compare the proportions of responses between the dissemination groups ('village meeting and video'; 'village meeting'; 'village meeting and handout'; 'village meeting, video and handout'; and 'handout' groups) and the control groups ('Control', and 'Hawthorne control' groups).

5.3.4.3 Volunteered responses: pre- and post- dissemination

Volunteered responses were those where the respondent volunteered the fact of interest in response to the initial open question. All subsequent analysis involved only the volunteered responses from respondents.

The frequencies of volunteered responses obtained pre- and post-dissemination were calculated, with post-dissemination responses being subdivided into two groups, a) those from respondents in the 'Control' groups or 'Hawthorne control' groups, and b) those from respondents in the 'village meeting', 'village meeting and handout', 'village meeting and video', 'village meeting, video and handout', and the 'handout' dissemination groups.

5.3.4.4 Change in knowledge of individuals: – pre- and post- dissemination scores

Following completion of both the pre- and post-dissemination questionnaires, an overall pre-and post-dissemination score was allocated to each individual, according to the number of volunteered answers given. These pre- and post-dissemination scores were then used to give an illustration of the change in knowledge for each individual respondent.

5.3.4.5 Statistical Modelling

5.3.4.5.1 Data storage and analysis

The strength of association between explanatory variable (e.g. dissemination method) and mastitis knowledge was examined by odds ratio (OR) and 95% confidence intervals (95% CI).

Calculation of odds ratios

Define:

p_1 = probability of volunteering correct mastitis fact post-dissemination if respondent in dissemination method group (e.g. 'village meeting and video')

p_2 = probability of volunteering correct mastitis fact post-dissemination if respondent in control group

$p_1/1-p_1$ = odds of volunteering correct mastitis fact post-dissemination if respondent in dissemination method group (e.g. 'village meeting and video')

$p_2/1-p_2$ = odds of volunteering correct mastitis fact post-dissemination if respondent in control group

$$\text{Odds Ratio} = \frac{p_1/1-p_1}{p_2/1-p_2}$$

Odds ratios, adjusted for the random effect of village, were calculated using the Egret (Gogte et al., 1999) programme. The Epi Info 6 Epitable programme (Coulombier et al., 2001) was used to calculate 95% CI by the exact binomial method. Odds ratios and confidence intervals obtained by these methods were then plotted as horizontal error bars using the S-Plus software programme (Mathsoft, 1988-1999), whilst other figures were drawn using the Microsoft Excel 2000 (Microsoft, 1985-1999) programme. Comparison of two or more proportions, to determine if they were significantly different, was done in Epi Info 6 Epitable (Coulombier et al., 2001) using the Chi squared test.

5.3.4.5.2 Multilevel modelling for overall mastitis knowledge

Multilevel models were constructed to examine the relationship between 'volunteering mastitis facts post-dissemination' (outcome variable) and the different dissemination methods employed (explanatory variables). This approach was used because data were arranged in a hierarchical manner, and it was necessary to account for, and estimate, the variation attributable to the different levels within the hierarchy. Two general hierarchical structures were used, the first comprising individual question clustered within farm clustered within village (Model 1), and the second comprising individual question clustered within question number clustered within question type (Model 2). As binary outcome responses were involved, a generalised linear model with a logit link function was used, which also had the useful property that the exponent of the coefficient was equal to the odds ratio for each outcome variable. The binomial responses for each mastitis fact on the questionnaire (excluding validation variables) were stacked using the S Plus programme, which resulted in a database of more than 28,000 responses to each question by each individual respondent.

Ideally, a cross classified model should have been used to account for all sources of variation within the dataset, however due to the size of the dataset, and the relatively low contribution from farm and village level, this was not considered to be necessary. This study only considered simple variation (random intercepts), hence the model considering two interventions, compared to a third control group, and a nested hierarchy of individual question, farm and village was of the form:

$$y_{ijk} \sim Binomial(1, p_{ijk})$$

$$y_{ijk} = p_{ijk} + e_{ijk} x_0^*$$

$$Ln\left(\frac{p_{ijk}}{1-p_{ijk}}\right) = \beta_1 + \beta_2 x_k + \beta_3 x_k + \nu_{1k} + \mu_{1jk}$$

$$[\nu_{1k}] \sim Normal(0, \Omega_\nu)$$

$$[\mu_{1jk}] \sim Normal(0, \Omega_\mu)$$

$$x_0^* = \sqrt{[p_{ijk}(1-p_{ijk})]}$$

Where
i = subscript representing individual questions
j = subscript representing farms
k = subscript representing villages
y_{ijk} = outcome for individual question i in farm j and village k
β_1 = constant (representing log odds in control group)
β_2 = coefficient for explanatory variable 1 (intervention 1)
β_3 = coefficient for explanatory variable 2 (intervention 2)
x_1 = 1 if dissemination method 1, otherwise 0
x_2 = 1 if dissemination method 2, otherwise 0
ν_k = 'error' term representing village-level residuals (level 3)
μ_{jk} = 'error' term representing farm-level residuals (level 2)
e_{ijk} = 'error' term representing individual question-level residuals (level 1)
Ω_ν = variance of ν
Ω_μ = variance of μ

and

e^{β_1} = Odds Ratio for dissemination method 1 (compared to control group)
e^{β_2} = Odds Ratio for dissemination method 2 (compared to control group)

The contributions of each level of clustering, individual question, farm and village in the first model, and individual question, question number and question type in the second model, to the variance were assessed by fitting intercept only, 3-level models. The proportion of variance attributed to each level was then estimated by calculating the approximation of the intra-class coefficient (ICC) using the latent variable approach and the binary linearisation model (Goldstein et al., 2000). The ICCs for both of the fixed term models were also calculated using the latent variable approach. The latent variable approach assumes that the binary outcome arises from an underlying continuous distribution and that the level 1 variance on the logit scale is $\pi^2/3$.

For both multilevel models, univariable screening of variables was performed for the binary outcome 'volunteering a correct mastitis fact post-dissemination' using the MLWin software (Rasbash et al., 2000). Binomial models were fitted to identify significant explanatory variables ($p \leq 0.05$) for the outcome variable. The estimation procedure used the second order penalised quasi-likelihood (PQL) and residual iterative generalised least squares (RIGLS) algorithm. The odds ratio (OR) was calculated by exponentiating the regression coefficient (β) of binary variables. The 95% CI was calculated by exponentiating ($\beta \pm 1.96SE$).

Dummy variables were created for categorical variables, with reference categories being selected either by logical reasoning e.g. selecting 'learned from nowhere' for volunteered methods of learning (Table 5-5), or by selecting the most common group amongst the overall population e.g. 'standard' grade for education level (Table 5-5). For those variables where it was difficult to select a reference category based on the previously stated criteria, univariable analysis was performed for all permutations of reference category, and the most appropriate then selected e.g. 'prevention' for question type (Table 5-5).

Six final models for the outcome variable 'volunteering mastitis facts post-dissemination', were then fitted using a 2nd order PQL method with a backward stepwise elimination procedure, and a critical probability of 0.05.

5.3.4.5.3 Multilevel modelling for change in mastitis knowledge

Multilevel models were also constructed to examine the relationship between the change in mastitis knowledge of an individual respondent, as defined by 'the difference between pre- and post-dissemination scores' (outcome variable), and explanatory variables, which included the different dissemination methods employed, in addition to other farm and village level variables (Model 3). A hierarchical structure comprising farm clustered within village was used. As the differences between pre- and post-dissemination scores were shown to follow a normal distribution, a multilevel linear regression model was used to assess the contribution of farm, and village, to the overall variation. The number of responses used for this model was limited to 252, which represented the number of respondents in the study from which both pre- and post-dissemination data had been collected. The 28 respondents in the 'Hawthorne control' group were excluded from this model, as, by intention, pre-dissemination data had not been collected from them.

The model considering two interventions, compared to a third control group, and a nested hierarchy of farm and village was of the form:

$$y_{ij} = \beta_1 + \beta_2 x_k + \beta_3 x_k + \mu_{1jk} + e_{ijk} x_0$$

$$[\mu_{1jk}] \sim \text{Normal}\ (0, \Omega_{\mu})$$

$$[e_{ijk}] \sim \text{Normal}\ (0, \Omega_{e})$$

Where
i = subscript representing farms
j = subscript representing villages
y_{ij} = outcome for farm i in village j
$\beta 1$ = constant (representing control group)
$\beta 2$ = coefficient for explanatory variable 1 (intervention 1)
$\beta 3$ = coefficient for explanatory variable 2 (intervention 2)
x1 = 1 if dissemination method 1, otherwise 0
x2 = 1 if dissemination method 2, otherwise 0
μ_{1jk} = 'error' term representing village-level residuals
e_{ijk} = 'error' term representing farm-level residuals
Ω_{μ} = variance of μ (or, village-level variance)
Ω_{e} = variance of e (or, farm-level variance)

The contribution to the variance of farm and village levels of clustering were assessed by fitting an intercept only, 2-level model. The proportion of variance attributed to each level was then estimated by calculating the approximation of the ICCs using simple proportions. The ICCs for the fixed term model (Model 3c) was also calculated using simple proportions.

Univariable screening of variables was performed for the continuous outcome variable 'difference between pre- and post-dissemination scores' using MLWin software (Rasbash et al, 2000). Potential explanatory variables were initially screened using univariable multilevel analysis. As the dataset in this model had reduced statistical power compared to the datasets used in Models 1 and 2, variables with $p<0.25$ were considered for inclusion in the final multilevel model. The estimation procedure used the residual iterative generalised least squares (RIGLS) algorithm. Identical dummy categories to those used in Models 1 and 2 were created for categorical variables.

Three final models for the outcome variable 'difference between pre- and post-dissemination scores' were then fitted with a backward stepwise elimination procedure, and a critical probability of 0.05.

5.3.4.6 Figures

Figures were illustrated graphically using Microsoft Excel 2000. Table 5.1 gives a more detailed explanation of the mastitis facts of interest included in the figures.

	Fact of interest shown in figure	**Explanation of fact of interest**	**Figure no**
Experience of mastitis	Heard of mastitis	Respondent had heard of the condition mastitis	5.11
	Own cow suffered	Respondent's own cow had suffered from mastitis	5.11
Methods of learning about mastitis	Nowhere	Respondent had not learnt about mastitis at all	5.12
	Buhuri	Respondent had learnt about mastitis from LITI Buhuri Training Institute	5.12
	EO	Respondent had learnt about mastitis from extension officer	5.12
	DFID Training	Respondent had learnt about mastitis from DFID Project training	5.12
	Other course	Respondent had learnt about mastitis from a training course other than DFID training	5.12
	Other farmers	Respondent had learnt about mastitis from discussion with fellow farmers	5.12
	Clinical case	Respondent had learnt about mastitis from seeing a clinical case of mastitis (not necessarily in their own cow)	5.12
	Pamphlets	Respondent had learnt about mastitis from reading pamphlets	5.12
	Other	Respondent had learnt about mastitis from a source other than those already mentioned	5.12
Identification of mastitis	Look at udder	Respondent inspected udder visually for abnormalities prior to milking	5.1, 5.13
	Palpate udder	Respondent inspected udder by palpation for abnormalities prior to milking	5.1, 5.13
	Inspect foremilk	Respondent inspected foremilk for abnormalities prior to milking	5.1, 5.13
Action taken on identifying mastitis	Seek advice	Respondents would seek advice e.g. from EO concerning further action to be taken	5.2, 5.14
	Increase frequency of milking	Respondent would increase the number of times per day the cow was milked	5.2, 5.14
Signs of mastitis	Unsure	Respondent was unsure of any signs associated with mastitis	5.15
	(Cough)	Respondent considered coughing to be a sign of mastitis (Validation variable)	5.3, 5.15
	Hot udder	Respondent considered a hot udder to be a sign of mastitis	5.3, 5.15
	Swollen udder	Respondent considered a swollen udder to be a sign of mastitis	5.3, 5.15
	Painful udder	Respondent considered a painful udder to be a sign of mastitis	5.3, 5.15
	Discoloured udder	Respondent considered a discoloured udder to be a sign of mastitis	5.3, 5.15
	(Lameness)	Respondent considered lameness to be a sign of mastitis (Validation variable)	5.3, 5.15

	Fact of interest shown on graph	Explanation of fact of interest	Figure no
	(Blindness)	Respondent considered blindness to be a sign of mastitis (Validation variable)	5.3, 5.16
	Clots/flakes	Respondent considered clots or flakes in the milk to be a sign of mastitis	5.4, 5.16
	Blood in milk	Respondent considered blood in the milk to be a sign of mastitis	5.4, 5.16
	Pus in milk	Respondent considered pus in the milk to be a sign of mastitis	5.4, 5.16
	Milk composition	Respondent considered an altered milk composition e.g. watery milk to be a sign of mastitis	5.4, 5.16
	(Diarrhoea)	Respondent considered diarrhoea to be a sign of mastitis (Validation variable)	5.4, 5.16
	Decreased yield	Respondent considered a decreased milk yield to be a sign of mastitis	5.4, 5.16
Effects of mastitis	Unsure	Respondent was unsure of any effects of mastitis	5.17
	Decreased yield	Respondent considered a decreased milk yield to be an effect of mastitis	5.5, 5.17
	Spread – quarters	Respondent considered the spread of mastitis from one quarter to another to be an effect of mastitis	5.5, 5.17
	Spread – cows	Respondent considered the spread of mastitis from one cow to another to be an effect of mastitis	5.5, 5.17
	(Conception)	Respondent considered decreased conception to be an effect of mastitis (Validation variable)	5.5, 5.17
	Keeping quality	Respondent considered the decreased keeping quality of milk to be an effect of mastitis	5.5, 5.17
	Sales of milk	Respondent considered the rejection of milk for sale to be an effect of mastitis	5.5, 5.17
	Zoonotic disease	Respondent considered the risk of transmission of zoonotic disease to be an effect of mastitis	5.5, 5.17
	Nutritional value	Respondent considered the decreased nutritional value of milk to be an effect of mastitis	5.5, 5.17
	Death / culling	Respondent considered the death or culling of a cow to be an effect of mastitis	5.5, 5.17
Spread of mastitis	Unsure	Respondent was unsure of any methods of spread of mastitis	5.18
	Teat to teat	Respondent considered that mastitis may be spread from one teat to another	5.6, 5.18
	Cow to cow	Respondent considered that mastitis may be spread from one cow to another	5.6, 5.18
	Herd to herd	Respondent considered that mastitis may be spread from one herd to another	5.6, 5.18
	(Grazing to cow)	Respondent considered that mastitis may be spread from grass to cow (Validation variable)	5.6, 5.18
	(Air to cow)	Respondent considered that mastitis may be spread from air to cow (Validation variable)	5.6, 5.18
	Insect to cow	Respondent considered that mastitis may be spread from insect to cow	5.6, 5.19
	Banda to cow	Respondent considered that mastitis may be spread from banda to cow	5.7, 5.19
	Hands to cow	Respondent considered that mastitis may be spread from milker's hands to cow	5.7, 5.19
	Water to cow	Respondent considered that mastitis may be spread from water to cow	5.7, 5.19
	U.cloth to cow	Respondent considered that mastitis may be spread from udder cloth to cow	5.7, 5.19

	Fact of interest shown on graph	Explanation of fact of interest	Figure no
	Lubricant to cow	Respondent considered that mastitis may be spread from teat lubricant to cow	5.7, 5.19
	Incomplete milking	Respondent considered that mastitis may be spread by using an incomplete milking technique	5.7, 5.19
Prevention of mastitis	Unsure	Respondent was unsure of any methods of prevention of mastitis	5.20
	Hygiene of banda	Respondent considered that the good hygiene of the banda was a method of prevention of mastitis	5.8, 5.20
	Hygiene of milker	Respondent considered that the good hygiene of the milker was a method of prevention of mastitis	5.8, 5.20
	Hygiene of udder cloth	Respondent considered that the good hygiene of the udder cloth was a method of prevention of mastitis	5.8, 5.20
	1 cloth per cow	Respondent considered that using one udder cloth per cow was a method of prevention of mastitis	5.8, 5.20
	1 corner per teat	Respondent considered that using one corner of the cloth per teat was a method of prevention of mastitis	5.8, 5.20
	Clean water	Respondent considered that using clean water to wash udder was a method of prevention of mastitis	5.8, 5.20
	Wash teats only	Respondent considered that washing only the teats, rather than the whole udder, was a method of prevention of mastitis	5.8, 5.21
	Wash with hand	Respondent considered that washing the udder using hands, rather than an udder cloth, was a method of prevention of mastitis	5.9, 5.21
	Dry with hand	Respondent considered that drying the udder using hands, rather than an udder cloth was a method of prevention of mastitis	5.9, 5.21
	Milking salve	Respondent considered that using special milking salve, rather than milk, cream or ghee, was a method of prevention of mastitis	5.9, 5.21
	Complete milking	Respondent considered that a complete milking technique was a method of prevention of mastitis	5.9, 5.21
	5 finger technique	Respondent considered that using a five finger squeezing milking technique, rather than a stripping technique, was a method of prevention of mastitis	5.9, 5.21
	Isolate	Respondent considered that isolation of the affected cow in a separate area of the banda was a method of prevention of mastitis	5.9, 5.21
	Isolate at bottom	Respondent considered that isolation of the affected cow in an area at the bottom of the banda slope was a method of prevention of mastitis	5.9, 5.22
	Affected cow last	Respondent considered that milking the affected cow last was a method of prevention of mastitis	5.10, 5.22
	Affected ¼ last	Respondent considered that milking the affected quarter last was a method of prevention of mastitis	5.10, 5.22
	Discard safely	Respondent considered that discarding affected milk safely was a method of prevention of mastitis	5.10, 5.22
	Separate container	Respondent considered that milking affected quarters into a separate container was a method of prevention of mastitis	5.10, 5.22
	Wash hands	Respondent considered that washing the hands after milking an affected cow was a method of prevention of mastitis	5.10, 5.22
	Treat cow	Respondent considered that treating the affected cow was a method of prevention of mastitis	5.10, 5.22

Table 5-1: Full explanation of the mastitis facts of interest illustrated in figures in this chapter

5.4 Results

5.4.1 All responses – post dissemination

Mastitis topics covered by the questionnaire included experience of mastitis, methods of learning about mastitis, identification of mastitis, action taken on identification of mastitis, signs of mastitis, effects of mastitis, spread of mastitis and prevention of mastitis.

For each fact illustrated, responses between the four categories, 'volunteered', 'prompted', 'no' and 'unsure' represented proportions of the total number of respondents. It could, therefore, be seen that for facts where a high proportion of respondents 'volunteered' the answer, the associated proportions of 'prompted', 'no' or 'unsure' responses were decreased.

5.4.1.1 Identification of mastitis

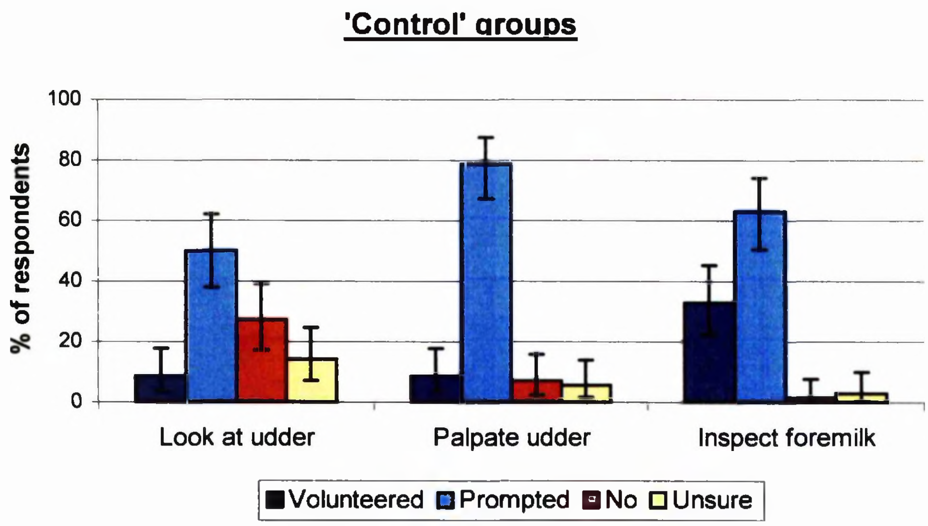
There were far fewer 'no' and 'unsure' responses to questions concerning identification of mastitis from respondents in the dissemination groups than those in the control groups. In addition, for all responses, there were a greater proportion of volunteered responses in the dissemination groups than in the control groups.

'Volunteered' responses: There were significant differences in the proportion of volunteered responses for 'palpating the udder' ($p = 0.001$, control groups (cg)=8.6%, dissemination groups (dg)=27.1%,), and for 'inspecting the foremilk' ($p<0.001$, cg=32.9%, dg=61.0%). The proportions of volunteered responses for 'looking at the udder' showed no significant differences between the groups (Fig 5-1).

'Prompted' responses: The proportions of prompted responses for 'inspecting the foremilk' showed a significant difference ($p<0.001$, cg=62.9%, dg=38.6%). The proportions of prompted responses for other mastitis facts associated with identification of mastitis showed no significant differences (Fig 5-1).

'No' responses: For all three facts associated with identification of mastitis, there was a higher proportion of 'no' responses in the control groups than in the dissemination groups, however the differences were not significant (Fig 5-1).

'Unsure' responses: For all three facts associated with the identification of mastitis, there was a higher proportion of 'unsure' responses in the control groups than in the dissemination groups, however the differences were not found to be statistically significant (Fig 5-1).



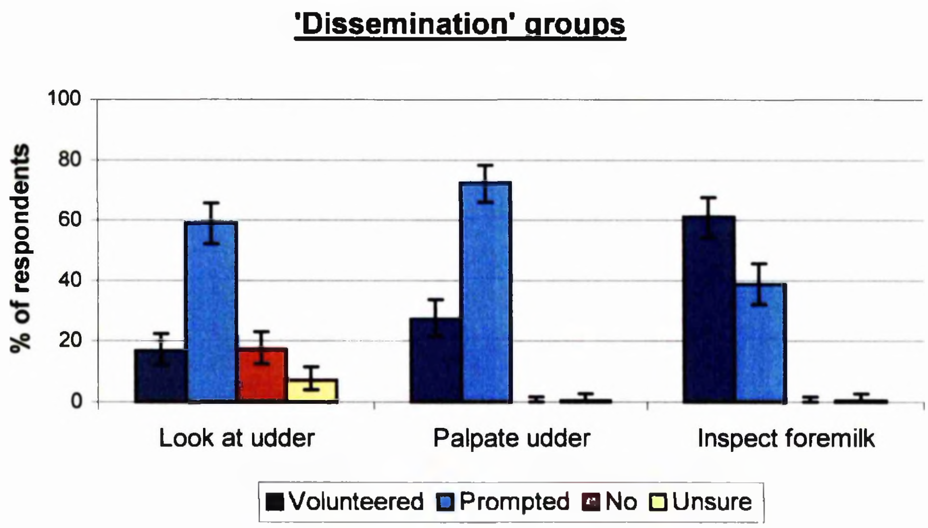


Figure 5-1: 'Identification of mastitis' post-dissemination responses for four categories of responses: 1) 'volunteered', 2) 'prompted', 3) 'no', and 4) 'unsure'. 'Control' groups refer to respondents in the 'Control' and 'Hawthorne control' groups (n=70), whilst 'Dissemination' groups refer to respondents in the five dissemination groups ('village meeting and video'; 'village meeting and handout'; 'village meeting, video and handout'; 'village meeting'; and 'handout' groups) (n=210). The exact binomial 95% confidence intervals are shown for each response.

5.4.1.2 Action taken on identification of mastitis

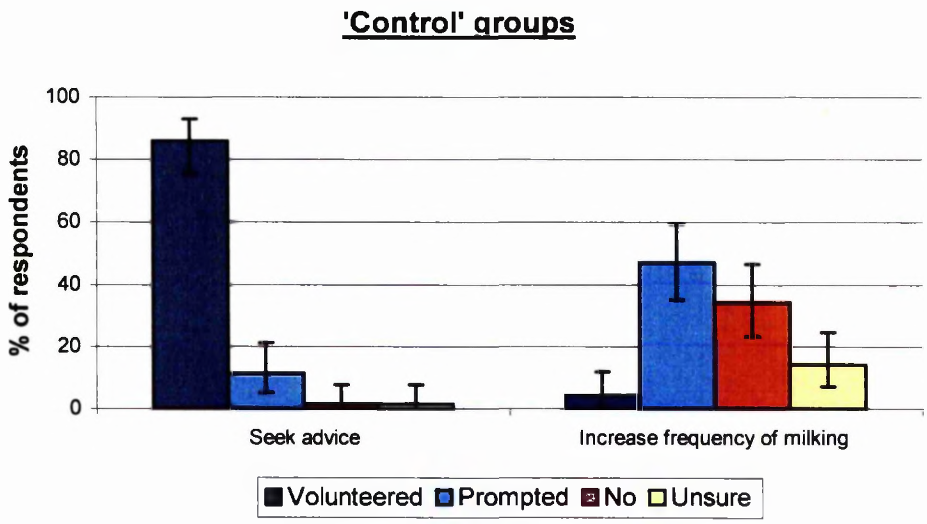
There was little difference between control and dissemination group responses for action taken on identification of mastitis.

'Volunteered' responses: The proportions of 'volunteered' responses for 'seeking advice' showed no significant differences, however, the proportions for 'increasing the frequency of milking' showed a significant difference ($p=0.013$, cg=4.3%, dg=15.7%) (Fig 5-2).

'Prompted' responses: The proportions of 'prompted' responses for 'seeking advice' showed no significant differences, however the proportions for 'increasing the frequency of milking' showed significant differences ($p=0.025$, cg=47.1%, dg=62.4%) (Fig 5-2).

'No' answers: The proportions of 'no' responses for 'seeking advice' showed no significant difference between groups, however the proportion for 'increasing the frequency of milking' showed a significant difference ($p=0.031$, cg=34.3%, dg=21.4%) (Fig 5-2).

'Unsure' answers: The proportions of 'unsure' responses for 'seeking advice' showed no significant differences between groups, however the proportions for 'increasing the frequency of milking' showed a significant difference ($p<0.01$, cg=14.3%, dg=0.5%) (Fig 5-2).



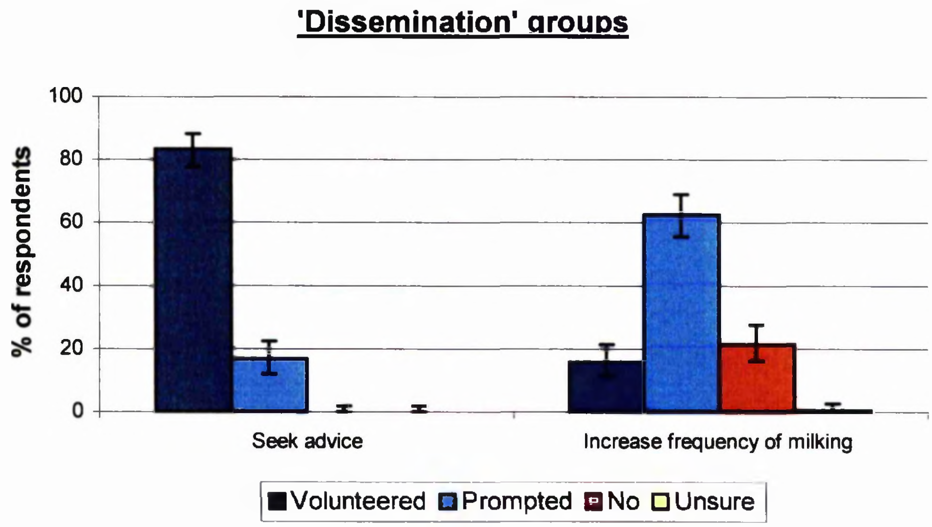


Figure 5-2: 'Action taken on identification of mastitis' post dissemination responses for four categories of responses: 1) volunteered, 2) prompted, 3) no, and 4) unsure. 'Control' groups refer to respondents in the 'Control' and 'Hawthorne control' groups (n=70), whilst 'Dissemination' groups refer to respondents in the five dissemination groups ('village meeting and video'; 'village meeting and handout'; 'village meeting, video and handout'; 'village meeting'; and 'handout' groups) (n=210). The exact binomial 95% confidence intervals are shown for each response.

5.4.1.3 Signs of mastitis

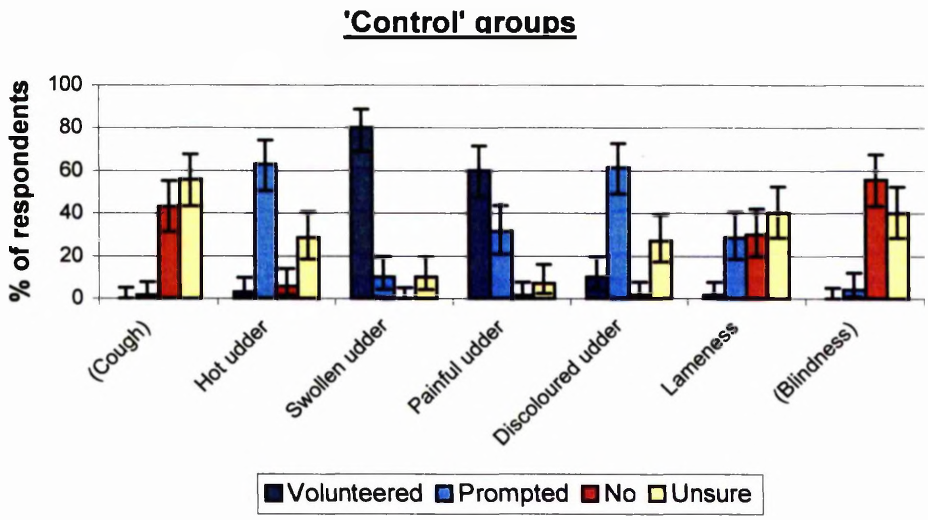
In general, responses for 'signs of mastitis' showed fewer 'no' and 'unsure' responses, and a greater proportion of 'volunteered' responses, from respondents in the dissemination groups when compared to the control groups. Responses given for the validation variables (or 'red herrings'), showed that respondents did not 'volunteer' any of these facts, and less than 7% of respondents gave prompted responses. In addition, the distributions of responses obtained for the validation variables were very similar between control and dissemination groups.

'Volunteered' responses: There were significant differences in the proportion of volunteered responses for 'hot udder' ($p<0.001$, cg=2.9%, dg=41.9%); 'swollen udder' ($p=0.020$, cg=80%, dg=90.5%); 'discoloured udder' ($p=0.001$, cg=10.0%, dg=29.0%), 'clots or flakes in milk' ($p=0.005$, cg=41.4%, dg=60.5%); and for 'blood in milk' ($p=0.004$, cg=30.0%, dg=50.0%). The proportions of all other volunteered responses showed no significant differences between control and dissemination groups (Figs 5-3 and 5-4).

'Prompted' responses: The proportions of prompted responses for 'clots or flakes in milk' ($p=0.050$, cg=51.4%, dg=38.1%), and 'decreased yield' ($p=0.006$, cg=40.0%, dg=59.0%) showed significant differences. The proportions of all other prompted responses showed no significant differences between dissemination and control groups (Fig 5-3 and 5-4).

'No' responses: The proportions of prompted responses for 'decreased yield' showed a significant difference ($p=0.042$, cg=18.6%, dg=9.5%). For all other facts associated with the identification of mastitis, there was a higher proportion of 'no' responses in the control groups than in the dissemination groups, however these were not found to be significant (Fig 5-3 and 5-4).

'Unsure' responses: There were significant differences in the proportion of volunteered responses for 'hot udder' ($p<0.001$, cg=28.6%, dg=4.8%); 'swollen udder' ($p<0.001$, cg=10.0%, dg=0%); 'discoloured udder' ($p<0.001$, cg=27.1%, dg=6.7%), 'lameness' ($p=0.011$, cg=40.0%, dg=24.3%); 'clots or flakes in milk' ($p=0.019$, cg=5.7%, dg=0.5%); 'blood in milk' ($p<0.001$, cg=12.9%, dg=1.9%); 'pus in milk' ($p<0.001$, cg=12.9%, dg=1.4%); 'altered milk composition' ($p=0.004$, cg=7.1%, dg=0.5%); and for 'decreased yield' ($p<0.001$, cg=17.1%, dg=3.8%). The proportions of all other 'unsure' responses showed no significant differences between dissemination and control groups (Fig 5-3 and 5-4).



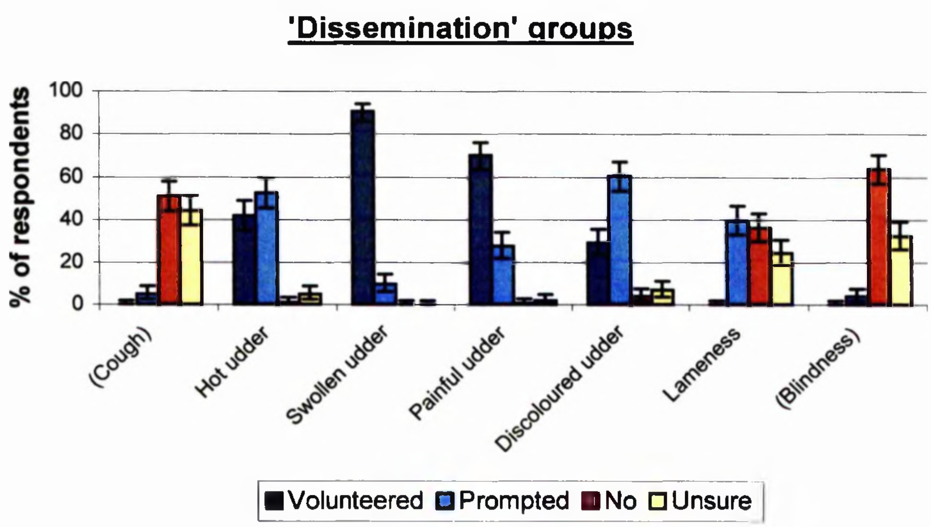
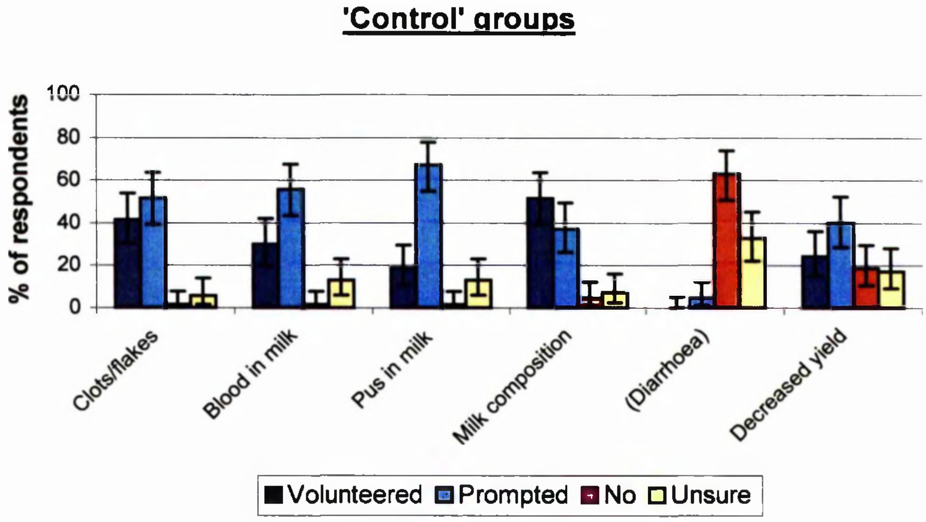


Figure 5-3: 'Signs of mastitis - 1' post- dissemination responses for four categories of responses: 1) volunteered, 2) prompted, 3) no, and 4) unsure. 'Control' groups refer to respondents in the 'Control' and 'Hawthorne control' groups (n=70), whilst 'Dissemination' groups refer to respondents in the five dissemination groups ('village meeting and video'; 'village meeting and handout'; 'village meeting, video and handout'; 'village meeting'; and 'handout' groups) (n=210). The exact binomial 95% confidence intervals are shown for each response.



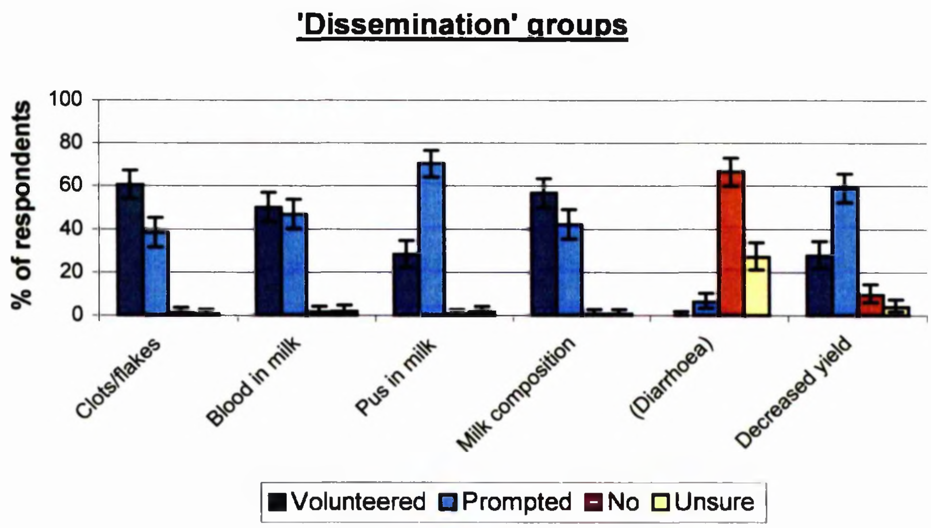


Figure 5-4: 'Signs of mastitis - 2' post dissemination responses for four categories of responses: 1) volunteered, 2) prompted, 3) no, and 4) unsure. 'Control' groups refer to respondents in the 'Control' and 'Hawthorne control' groups (n=70), whilst 'Dissemination' groups refer to respondents in the five dissemination groups ('village meeting and video'; 'village meeting and handout'; 'village meeting, video and handout'; 'village meeting'; and 'handout' groups) (n=210). The exact binomial 95% confidence intervals are shown for each response.

5.4.1.4 Effects of mastitis

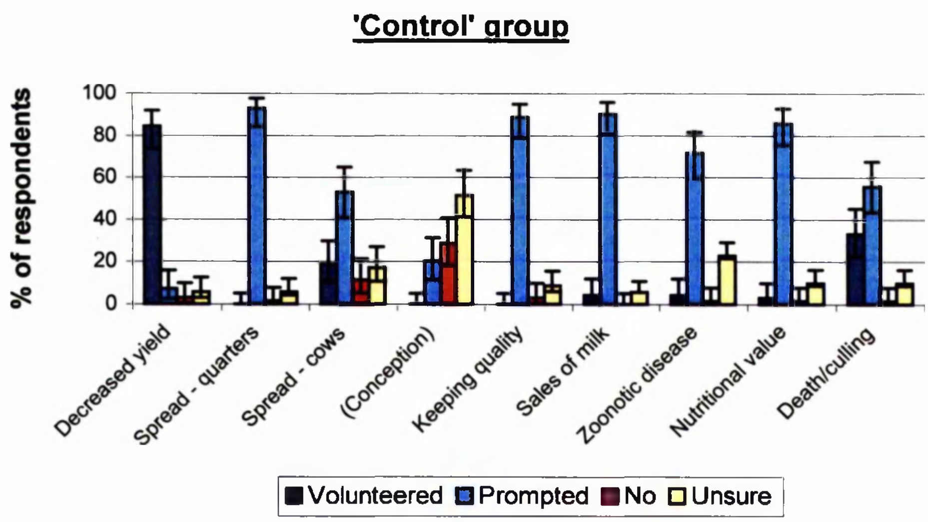
For all facts concerning the effects of mastitis, there was a much greater proportion of 'prompted' responses than 'volunteered', 'no' or 'unsure' responses. In addition, with the exception of 'decreased yield', there were a greater proportion of 'volunteered' responses in the dissemination groups than in the control groups. Amongst the dissemination groups there was an extremely small proportion of 'no' or 'unsure' responses, whilst in the control groups this proportion was far greater.

'Volunteered' responses: There were significant differences in the proportion of volunteered responses for 'spread to other quarters' ($p<0.01$, cg=0%, dg=25.2%); 'spread to other cows' ($p<0.001$, cg=18.6%, dg=62.4%); 'decreased keeping quality of milk' ($p<0.001$, cg=0%, dg=17.1%); 'decreased sales of milk' ($p<0.001$, cg=4.3%, dg=41.4%); for 'zoonotic disease' ($p<0.001$, cg=4.3%, dg=43.8%); 'decreased nutritional value' ($p<0.001$, cg=2.9%, dg=21.0%); and for 'death or culling of the cow' ($p<0.001$, cg=32.9%, dg=71.9%). The proportions of volunteered responses for 'decreased yield' and 'decreased conception' showed no significant difference (Fig 5-5).

'Prompted' responses: There were significant differences in the proportion of prompted responses for 'decreased yield' ($p=0.006$, cg=7.1%, dg=21.9%); 'spread to other quarters' ($p<0.01$, cg=92.9%, dg=72.9%); 'spread to other cows' ($p=0.021$, cg=52.9%, dg=37.1%); 'decreased sales of milk' ($p<0.001$, cg=90.0%, dg=58.1%); 'zoonotic disease' ($p=0.012$, cg=71.4%, dg=54.3%); and for 'death or culling of the cow' ($p<0.001$, cg=55.7%, dg=27.1%). The proportions of prompted responses for 'decreased conception', 'decreased keeping quality', and 'decreased nutritional value' showed no significant differences (Fig 5-5).

'No' responses: There were significant differences in the proportion of 'no' responses for 'spread to other cows' ($p<0.01$, cg=11.4%, dg=0.5%); and for 'decreased conception' ($p=0.014$, cg=28.6%, dg=45.2%) (Fig 5-5).

'Unsure' responses: All facts associated with the effects of mastitis showed statistically significant differences in the proportion of 'unsure' responses between dissemination and control groups. These included the proportion of 'unsure' responses for 'decreased yield' ($p=0.019$, cg=5.7%, dg=0.5%); 'spread to other quarters' ($p=0.004$, cg=5.7%, dg=0%); for 'spread to other cows' ($p<0.001$, cg=17.1%, dg=0%); 'decreased conception' ($p=0.05$, cg=51.4%, dg=32.9%); 'decreased keeping quality of milk' (p<0.001, cg=8.6%, dg=0.5%); 'decreased sales of milk' (p=0.004, cg=5.7%, dg=0%); 'zoonotic disease' (p<0.001, cg=22.9%, dg=1.0%); 'decreased nutritional value' (p<0.001, cg=10.0%, dg=0%); and for 'death or culling of the cow' (p<0.001, cg=10.0%, dg=0.5%) (Fig 5-5).



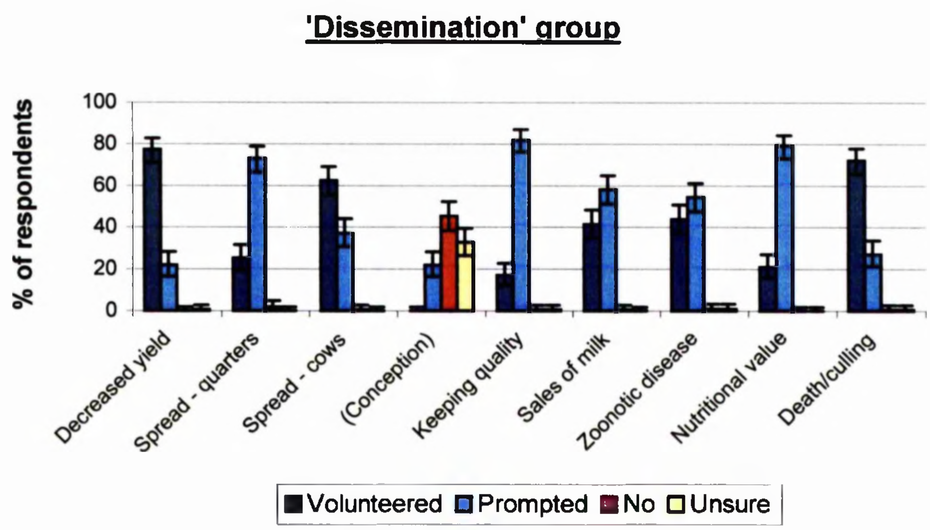


Figure 5-5: 'Effects of mastitis' post dissemination responses for four categories of responses: 1) volunteered, 2) prompted, 3) no, and 4) unsure. 'Control' groups refer to respondents in the 'Control' and 'Hawthorne control' groups (n=70), whilst 'Dissemination' groups refer to respondents in the five dissemination groups ('village meeting and video'; 'village meeting and handout'; 'village meeting, video and handout'; 'village meeting'; and 'handout' groups) (n=210). The exact binomial 95% confidence intervals are shown for each response.

5.4.1.5 Spread of mastitis

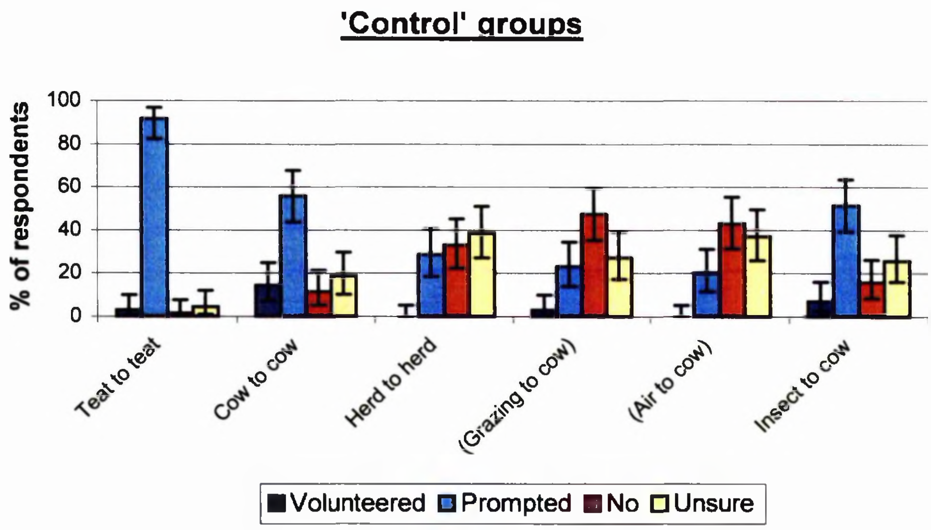
For all facts concerning the 'spread of mastitis', there were a greater proportion of 'volunteered' responses in the dissemination groups than in the control groups. With the exception of the validation variables 'grazing to cow' and 'air to cow' there was an extremely small proportion of 'no' or 'unsure' responses amongst the dissemination groups, whilst in the control groups this proportion was far greater.

'Volunteered' responses: There were significant differences in the proportion of volunteered responses for 'teat to teat' ($p<0.01$, cg=2.9%, dg=29.0%); 'cow to cow' ($p<0.01$, cg=14.3%, dg=66.7%); 'insect to cow' ($p<0.01$, cg=7.1%, dg=67.1%); 'banda to cow' ($p<0.01$, cg=25.7%, dg=75.2%); 'hands to cow' ($p<0.01$, cg=22.9%, dg=64.3%); 'water to cow' ($p<0.01$, cg=1.4%, dg=18.1%); 'udder cloth to cow' ($p<0.01$, cg=7.1%, dg=58.6%); and for 'lubricant to cow' ($p<0.01$, cg=0%, dg=11.0%) (Figs 5-6 and 5-7).

'Prompted' responses: There were significant differences in the proportion of prompted responses for 'teat to teat' ($p<0.001$, cg=91.4%, dg=69.0%); 'cow to cow' ($p<0.01$, cg=55.7%, dg=32.9%); 'herd to herd' ($p<0.01$, cg=28.6%, dg=76.7%); 'insect to cow' ($p<0.01$, 51.4%=cg, dg=31.9%); for 'banda to cow' ($p<0.01$, cg=40.0%, dg=24.3%); 'hands to cow' ($p<0.01$, cg=40.0%, dg=24.3%); 'udder cloth to cow' ($p<0.01$, cg=72.9%, dg=40.5%); and for 'lubricant to cow' ($p<0.01$, cg=55.7%, dg=74.8%). The proportions of prompted responses for other mastitis facts associated with transmission of mastitis showed no significant differences (Figs 5-6 and 5-7).

'No' responses: There were significant differences in the proportion of prompted responses for 'cow to cow' ($p<0.01$, cg=11.4%, dg=0.5%); 'herd to herd' ($p<0.01$, cg=32.9%, dg=15.2%); 'insect to cow' ($p<0.01$, cg=15.7%, dg=0.5%); 'banda to cow' ($p<0.01$, cg=15.7%, dg=0.5%); 'hands to cow' ($p<0.01$, 8.6%=cg, 0% = dg); 'water to cow' ($p<0.01$, cg=12.9%, dg=2.9%); 'udder cloth to cow' ($p<0.01$, cg=11.4%, dg=0.5%); and for 'lubricant to cow' ($p<0.01$, cg=24.3%, dg=9.5%). The proportions of prompted responses for other mastitis facts associated with transmission of mastitis showed no significant differences (Figs 5-6 and 5-7).

'Unsure' responses: There were significant differences in the proportion of 'unsure' responses for 'cow to cow' ($p<0.01$, cg=18.6%, dg=0%); 'herd to herd' ($p<0.01$, cg=38.6%, dg=4.3%); 'insect to cow' ($p<0.01$, cg=25.7%, dg=0.5%); 'banda to cow' (p<0.01, cg=18.6%, dg=0%); 'hands to cow' (p<0.01, cg=12.9%, dg=0%); 'water to cow' (p<0.01, cg=15.7%, dg=1.0%); 'udder cloth to cow' (p<0.01, cg=8.6%, dg=0.5%); and for 'lubricant to cow' (p<0.01, cg=20.0%, dg=4.8%). The proportions of unsure responses for other mastitis facts associated with transmission of mastitis showed no significant differences (Figs 5-6 and 5-7).



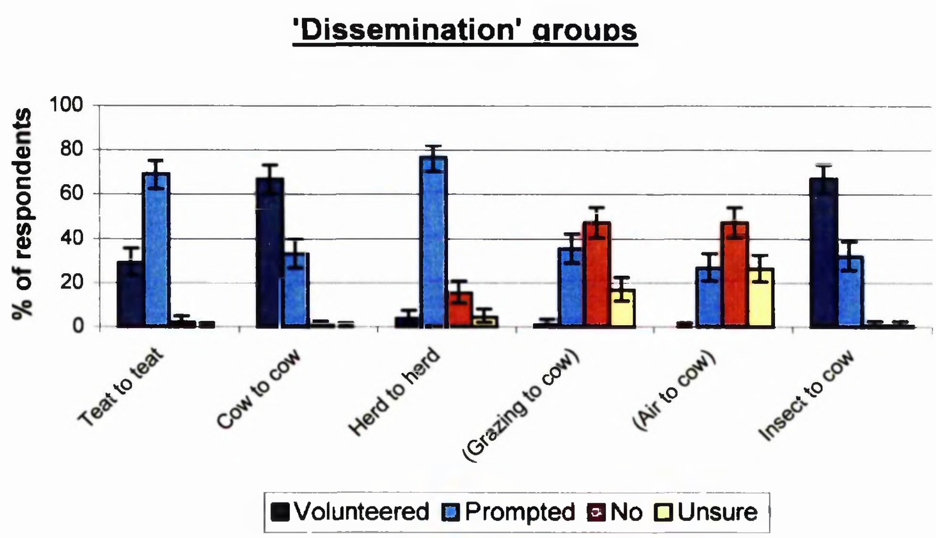
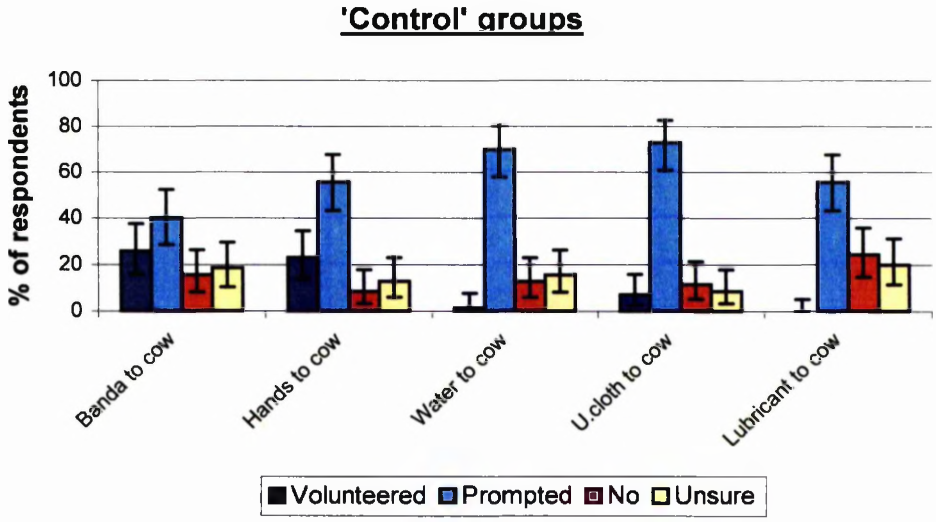


Figure 5-6: 'Spread of mastitis - 1' post- dissemination responses for four categories of responses: 1) volunteered, 2) prompted, 3) no, and 4) unsure. 'Control' groups refer to respondents in the 'Control' and 'Hawthorne control' groups (n=70), whilst 'Dissemination' groups refer to respondents in the five dissemination groups ('village meeting and video'; 'village meeting and handout'; 'village meeting, video and handout'; 'village meeting'; and 'handout' groups) (n=210). Exact binomial 95% confidence intervals are shown for each response.



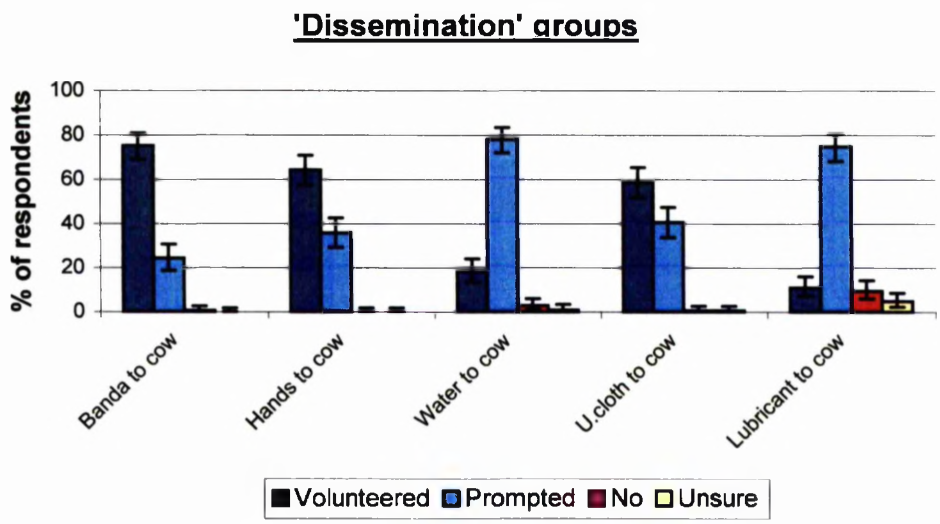


Figure 5-7: 'Spread of mastitis - 2' post dissemination responses for four categories of responses: 1) volunteered, 2) prompted, 3) no, and 4) unsure. 'Control' groups refer to respondents in the 'Control' and 'Hawthorne control' groups (n=70), whilst 'Dissemination' groups refer to respondents in the five dissemination groups ('village meeting and video'; 'village meeting and handout'; 'village meeting, video and handout'; 'village meeting'; and 'handout' groups) (n=210). The exact binomial 95% confidence intervals are shown for each response.

5.4.1.6 Prevention of mastitis

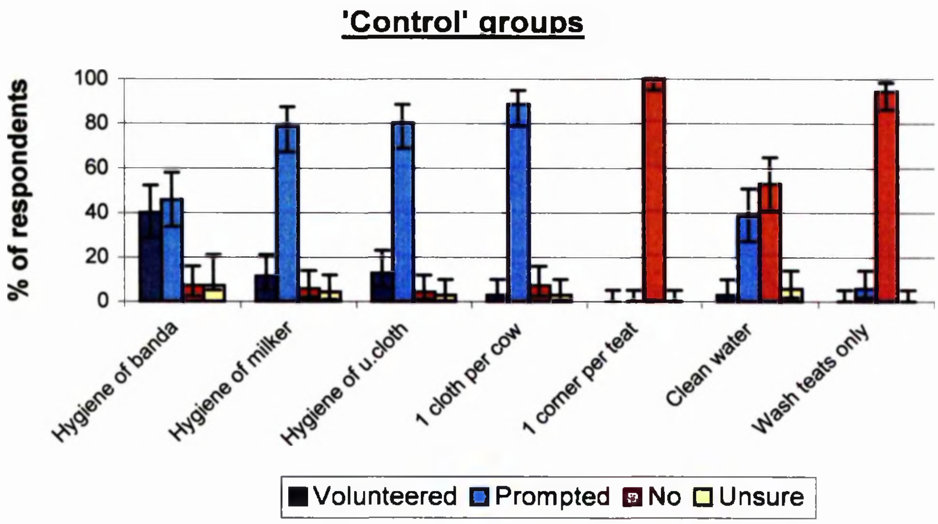
There were a greater proportion of 'volunteered' responses, for facts concerning the prevention of mastitis, in the dissemination groups than there was in the control groups. In addition there were fewer 'no' and 'unsure' answers in the dissemination groups than in the control groups. One fact concerning prevention of mastitis, namely 'drying the teats by hand' had a high proportion of 'no' answers amongst respondents in both the control and dissemination groups.

'Volunteered' responses: There were significant differences in the proportion of volunteered responses for 'hygiene of the banda' ($p<0.01$, cg=40.0%, dg=81.0%); 'hygiene of the milker' ($p<0.01$, cg=11.4%, dg=36.2%); 'hygiene of udder cloth' ($p<0.01$, cg=12.9%, dg=48.1%); 'one cloth per cow' ($p<0.01$, cg=2.9%, dg=33.8%); 'one corner per teat' ($p<0.01$, cg=0%, dg=31.4%); 'clean water' ($p=0.032$, cg=2.9%, dg=11.4%); 'complete milking' ($p<0.01$, cg=34.3%, dg=12.9%); 'isolate cow' ($p<0.01$, cg=4.3%, dg=40.5%); 'isolate cow at bottom of slope' ($p<0.01$, cg=0%, dg=11.4%); 'milk affected cow last' ($p=0.022$, cg=5.7%, dg=16.7%); 'milk affected quarter last' ($p<0.01$, cg=11.4%, dg=27.1%); 'discard milk safely' ($p<0.01$, cg=12.9%, dg=37.1%); and for 'wash hands' ($p=0.016$, cg=4.3%, dg=15.2%) (Figs 5-8, 5-9 and 5-10).

'Prompted' responses: There were significant differences in the proportion of prompted responses for 'hygiene of banda' ($p<0.001$, cg=45.7%, dg=19.0%); 'hygiene of milker' ($p=0.022$, cg=78.6%, dg=63.8%); 'hygiene of udder cloth' ($p<0.01$, cg=80.0%, dg=51.4%); 'one cloth per cow' ($p<0.01$, cg=88.6%, dg=65.7%); 'one corner per teat' ($p<0.01$, cg=0%, dg=41.4%); 'wash teats only' ($p<0.01$, cg=5.7%, dg=42.4%); 'use milking salve' ($p<0.01$, cg=20.0%, dg=51.4%); 'isolate at bottom of slope' ($p<0.01$, cg=0%, dg=19.5%); and for 'treat cow' ($p<0.01$, cg=68.6%, dg=85.7%). The proportions of prompted responses for other mastitis facts associated with prevention of mastitis showed no significant difference (Figs 5-8, 5-9 and 5-10).

'No' responses: There were significant differences in the proportion of prompted responses for 'hygiene of banda' ($p<0.01$, cg=7.1%, dg=0%); 'hygiene of milker' ($p<0.01$, cg=5.7%, dg=0%); 'one cloth per cow' ($p<0.01$, cg=7.1%, dg=0%); 'one corner per teat' ($p<0.01$, cg=100.0%, dg=25.7%); 'clean water' ($p=0.025$, cg=52.9%, dg=37.6%); 'wash teats only' ($p<0.01$, cg=94.3%, dg=55.2%); 'use milking salve' ($p<0.01$, cg=68.6%, dg=35.7%); 'complete milking' ($p<0.01$, cg=60.0%, dg=81.9%); 'isolate cow' ($p<0.01$, cg=27.1%, dg=10.5%); 'isolate at bottom of slope' ($p<0.01$, cg=87.1%, dg=67.1%); and for 'discard milk safely' ($p<0.01$, cg=12.9%, dg=1.0%). The proportions of 'no' responses for other mastitis facts associated with prevention of mastitis showed no significant difference (Figs 5-8, 5-9 and 5-10).

'Unsure' responses: There were significant differences in the proportion of 'unsure' responses for 'hygiene of banda' ($p<0.01$, cg=7.1%, dg=0%); 'clean water' ($p=0.019$, cg=5.7%, dg=0.5%); 'isolate cow' ($p<0.01$, cg=15.7%, dg=1.0%); 'isolate cow at bottom of slope' ($p<0.01$, cg=12.9%, dg=1.0%); 'discard milk safely' ($p<0.01$, cg=5.7%, dg=0%); and for 'separate container' ($p<0.01$, cg=5.7%, dg=0%). The proportions of unsure responses for other mastitis facts associated with prevention of mastitis showed no significant difference (Figs 5-8, 5-9 and 5-10).



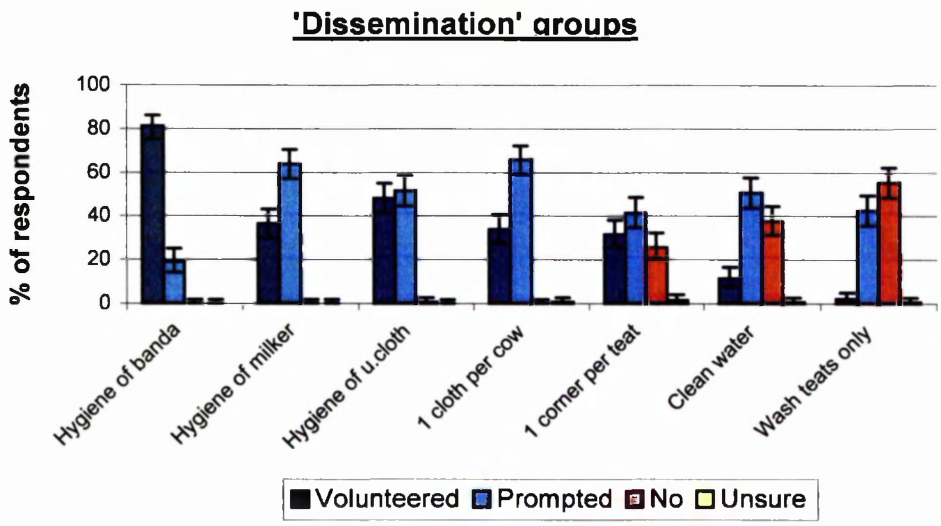
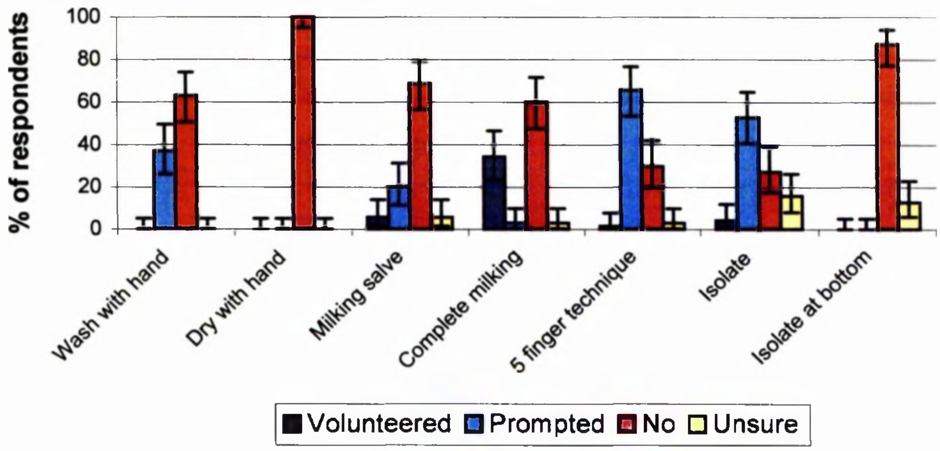


Figure 5-8: 'Prevention of mastitis - 1' post dissemination responses for four categories of responses: 1) volunteered, 2) prompted, 3) no, and 4) unsure. 'Control' groups refer to respondents in the 'Control' and 'Hawthorne control' groups (n=70), whilst 'Dissemination' groups refer to respondents in the five dissemination groups ('village meeting and video'; 'village meeting and handout'; 'village meeting, video and handout'; 'village meeting'; and 'handout' groups) (n=210). The exact binomial 95% confidence intervals are shown for each response.

'Control' groups



'Dissemination' groups

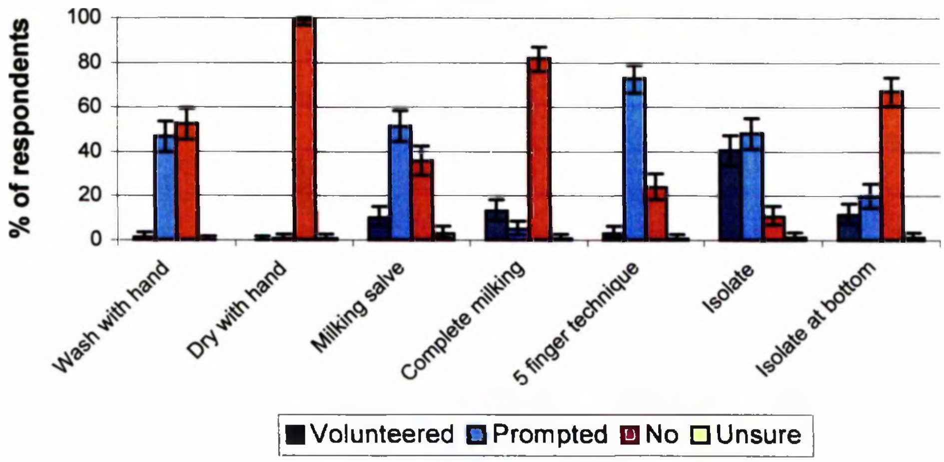
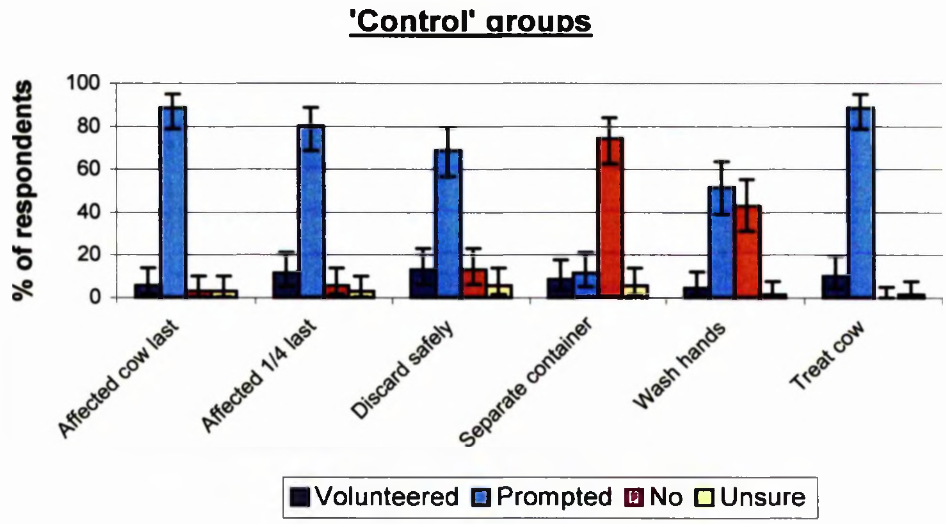


Figure 5-9: 'Prevention of mastitis - 2' post dissemination responses for four categories of responses: 1) volunteered, 2) prompted, 3) no, and 4) unsure. 'Control' groups refer to respondents in the 'Control' and 'Hawthorne control' groups (n=70), whilst 'Dissemination' groups refer to respondents in the five dissemination groups ('village meeting and video'; 'village meeting and handout'; 'village meeting, video and handout'; 'village meeting'; and 'handout' groups) (n=210). The exact binomial 95% confidence intervals are shown for each response.



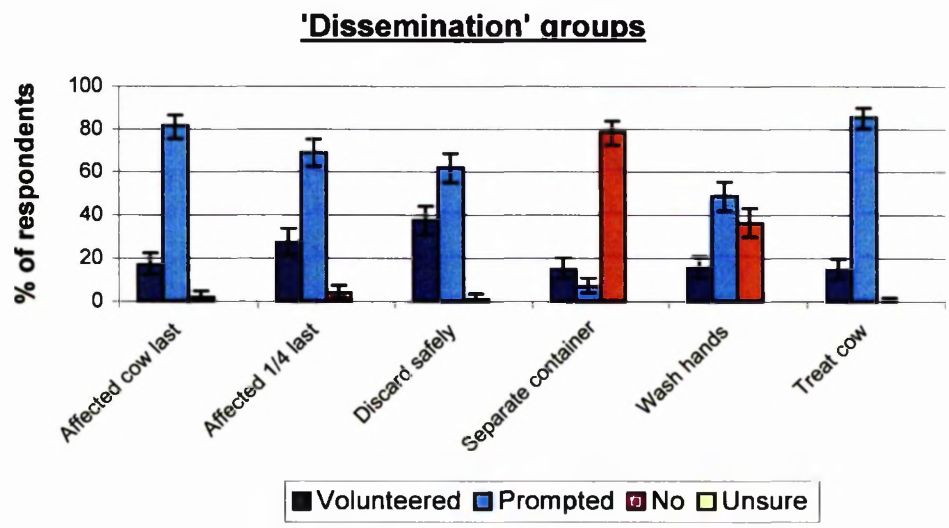


Figure 5-10: 'Prevention of mastitis - 3' post dissemination responses for four categories of responses: 1) volunteered, 2) prompted, 3) no, and 4) unsure. 'Control' groups refer to respondents in the 'Control' and 'Hawthorne control' groups (n=70), whilst 'Dissemination' groups refer to respondents in the five dissemination groups ('village meeting and video'; 'village meeting and handout'; 'village meeting, video and handout'; 'village meeting'; and 'handout' groups) (n=210). The exact binomial 95% confidence intervals are shown for each response.

5.4.1.7 Education level of respondents

Responses from the post-dissemination questionnaire revealed that the education level of respondents varied considerably, as 2.9% of respondents had received no education at all, 48.9% had received standard (primary) level education, 28.2% had received form (secondary) level education, and 20.0% had received higher education, which included completion of a certificate, diploma, or degree (data not shown).

5.4.2 Volunteered responses: pre- and post- dissemination

The proportions of volunteered responses obtained from respondents pre-dissemination (n=252), and both post-dissemination 'Control and Hawthorne control' (n=70) groups and 'dissemination' groups (n=210) were compared by chi squared analysis.

5.4.2.1 Experience of mastitis

Question = *"Have you heard of mastitis ?"*

Prior to dissemination, 90.9% of respondents had heard of mastitis, and following dissemination this proportion had risen significantly to 98.6% in the Control and Hawthorne control groups ($p<0.05$), and 99.5% in dissemination groups ($p<0.001$) (Fig 5-11).

Question = "Has your cow ever suffered from mastitis ?"

Prior to the dissemination programme, only 45.6% of respondents volunteered that their cow had suffered from mastitis, and following the dissemination programme this figure had risen to 57.1% in Control and Hawthorne control groups, and 49.0% in dissemination groups (Fig 5-11), however neither of these increases were shown to be significant.

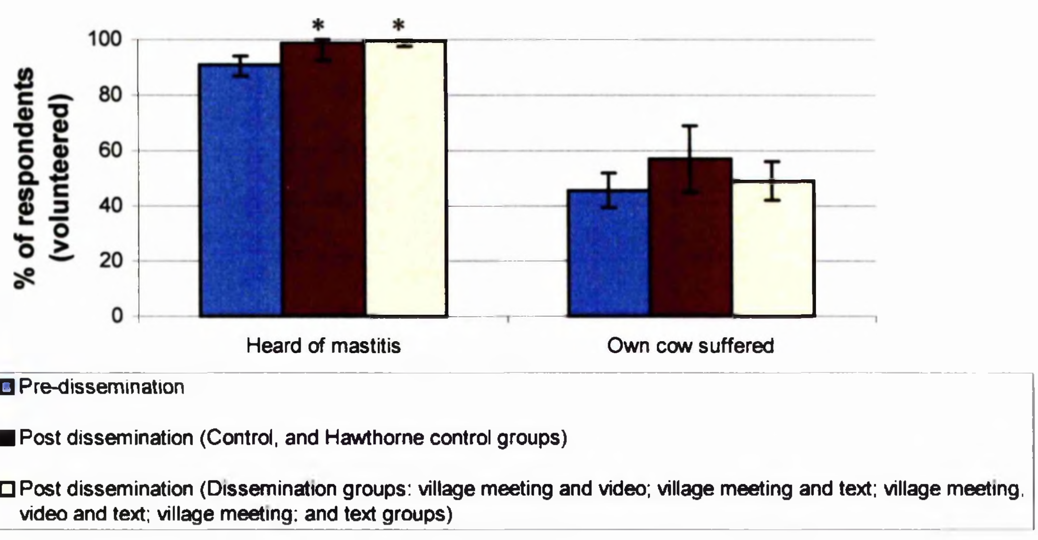


Figure 5-11: 'Experience of mastitis' volunteered responses for three categories of respondents. The exact binomial 95% confidence intervals are shown for each response. * indicates a significant difference compared to the control group.

5.4.2.2 Methods of learning about mastitis

Question = *"Where did you learn about mastitis ?"*

Prior to the dissemination programme, 26.2% of respondents volunteered that they had not received mastitis training, and following the dissemination programme this figure had increased to 35.7% (non significant) in the Control and Hawthorne control groups, and significantly decreased to 16.7% ($p<0.05$) in dissemination groups (Fig 5-12).

The methods of learning about mastitis varied considerably amongst respondents. The most commonly volunteered method of learning about mastitis was from LITI Buhuri, accounting for 37.3% of respondents prior to dissemination, and 41.4% (non-significant) of respondents in Control and Hawthorne control groups, and 39.0% (non-significant) in dissemination groups post-dissemination. The EO was the second most commonly volunteered method of learning about mastitis, and the proportion of respondents volunteering this method in both post-dissemination groups decreased significantly ($p<0.01$). Other methods of learning about mastitis were volunteered by small proportions of respondents (Fig 5-12). Respondents in the 'pre- dissemination' groups and 'post-dissemination' control groups did not receive project training, and, therefore, only post dissemination responses from the five dissemination groups are represented in Fig 5-12.

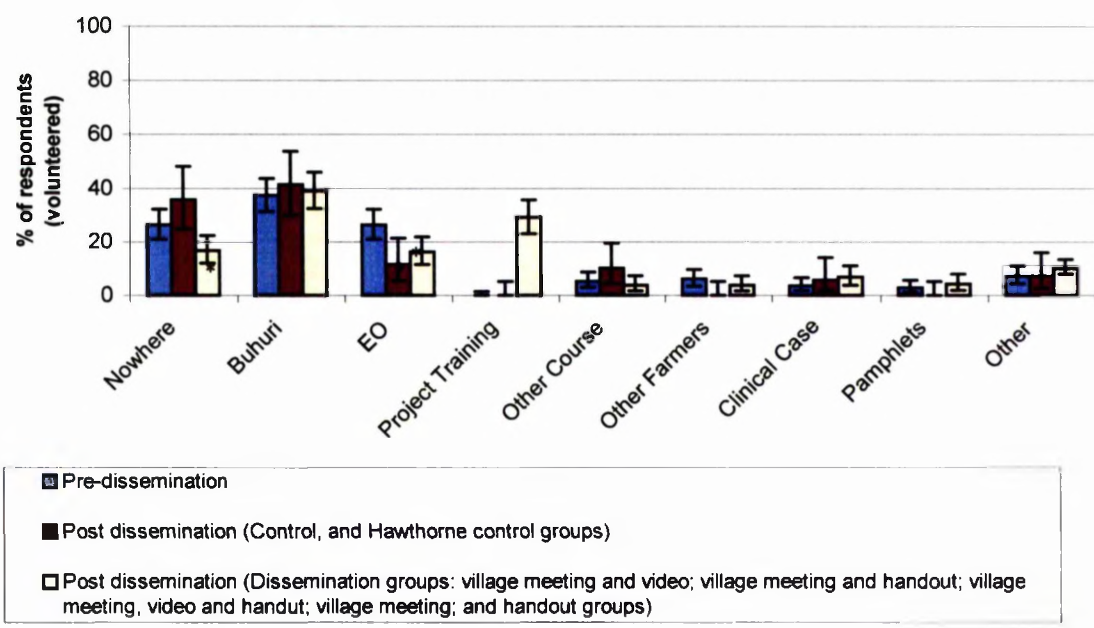


Figure 5-12: 'Methods of learning about mastitis' volunteered responses for three categories of respondents. The exact binomial 95% confidence intervals are shown for each response. * indicates a significant difference compared to the control group.

5.4.2.3 Identification of mastitis

Question = *"How would you check your cow for mastitis before milking?"*

Prior to the dissemination programme the proportion of respondents volunteering any of the three main facts associated with checking for mastitis was extremely small. However, following dissemination, this proportion had increased in the control groups, and had increased considerably in the dissemination groups. Of particular note was the fact that, prior to dissemination, only 5.2% of respondents volunteered that they checked the foremilk, however, following dissemination, this proportion had risen to 61.0% ($p<0.0001$) amongst respondents in the dissemination groups (Fig 5-13).

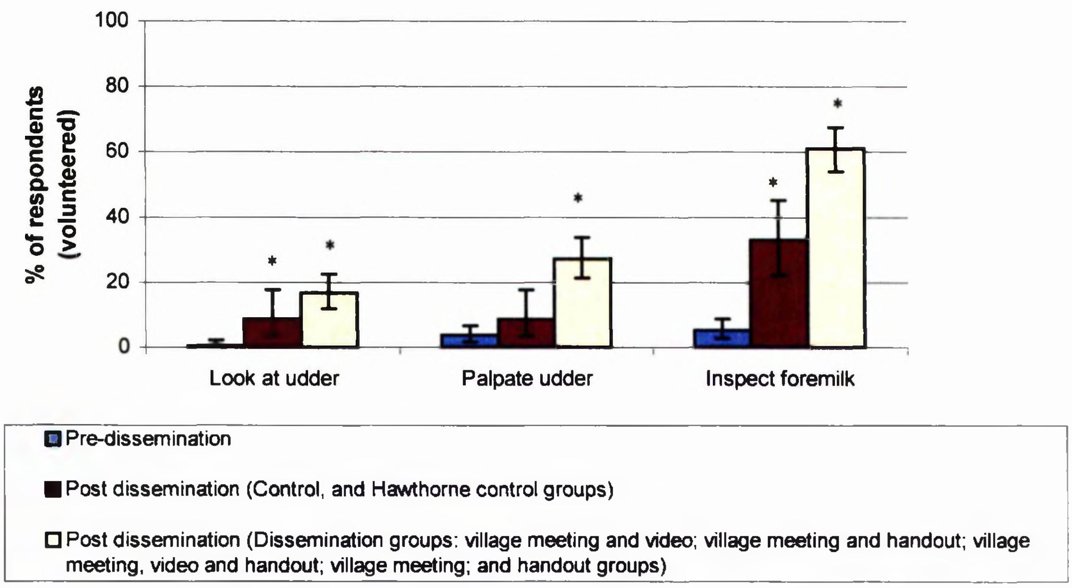


Figure 5-13: 'Identification of mastitis' volunteered responses for three categories of respondents. The exact binomial 95% confidence intervals are shown for each response. * indicates a significant difference compared to the control group.

5.4.2.4 Action taken on identifying mastitis

Question = *"What action would you take if you identified mastitis in your cow ?"*

A large proportion of respondents volunteered that they would seek advice following identification of mastitis in their cow. There was, however, no significant change seen following dissemination, with 76.2% of respondents volunteering this fact prior to dissemination, and 85.7% of respondents in Control and Hawthorne control groups and

83.3% of respondents in dissemination groups volunteering this fact following dissemination (Fig 5-14).

Few respondents volunteered the fact that they would increase the frequency of milking following identification of mastitis. Prior to dissemination only 1.6% of respondents volunteered that they would increase the frequency of milking following identification of mastitis, however following dissemination this proportion had increased to 4.3% (non significant) of respondents in Control and Hawthorne control groups, and 15.7% ($p<0.0001$) of respondents in dissemination groups (Fig 5-14).

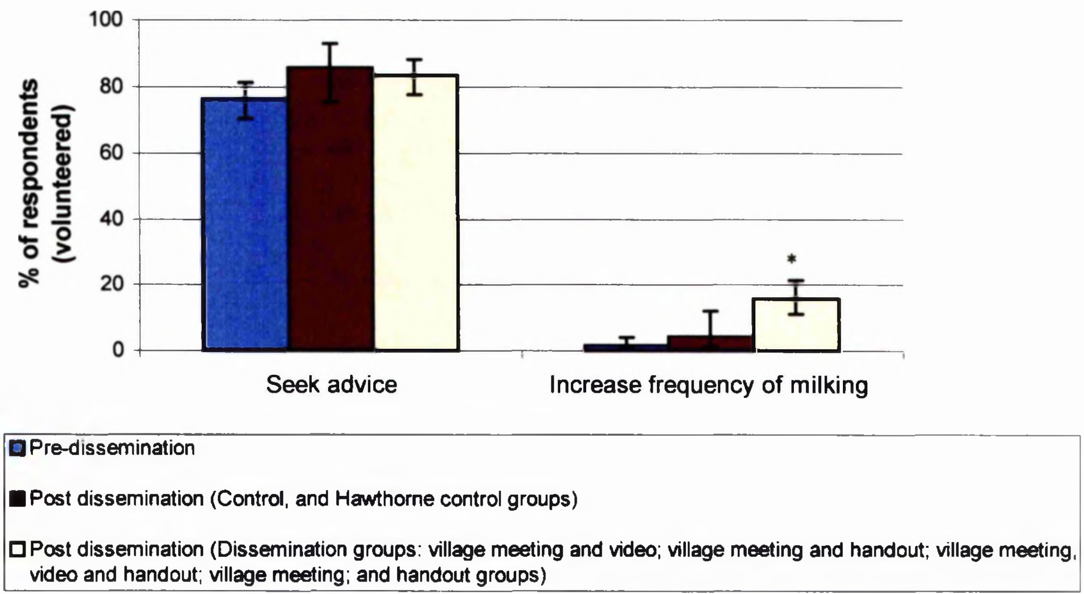


Figure 5-14: 'Action taken on identifying mastitis' volunteered responses for three categories of respondents. The exact binomial 95% confidence intervals are shown for each response. * indicates a significant difference compared to the control group.

5.4.2.5 Signs of mastitis

Question = *'What signs do you associate with mastitis ?'*

Prior to dissemination 13.5% of respondents were unsure of the clinical signs of mastitis, however, following dissemination none of the respondents in either the control ($p<0.0001$) or the dissemination groups ($p<0.0001$) were unsure of the signs, and were able to volunteer at least one sign of mastitis. Following dissemination, there was an increase in the proportion of respondents volunteering each sign of interest. Of particular note was the fact that prior to dissemination only 4.8% of respondents were able to volunteer the fact that a 'hot udder' was a sign of mastitis, whilst following dissemination this proportion had increased to 41.9% ($p<0.0001$) in respondents in the dissemination groups. In addition, prior to dissemination only 37.7% of respondents were able to volunteer 'painful udder', 22.6% of respondents were able to volunteer 'clots in the milk', and only 25.4% of respondents were able to volunteer 'alterations in milk composition' as signs of mastitis, however, following dissemination these proportions had significantly increased to 70.0% ($p<0.0001$), 60.5% ($p<0.0001$), and 56.7% ($p<0.0001$) respectively amongst respondents in the dissemination groups. The validation variables coughing, blindness, and diarrhoea, were not volunteered by any respondents (Figs 5-15 and 5-16).

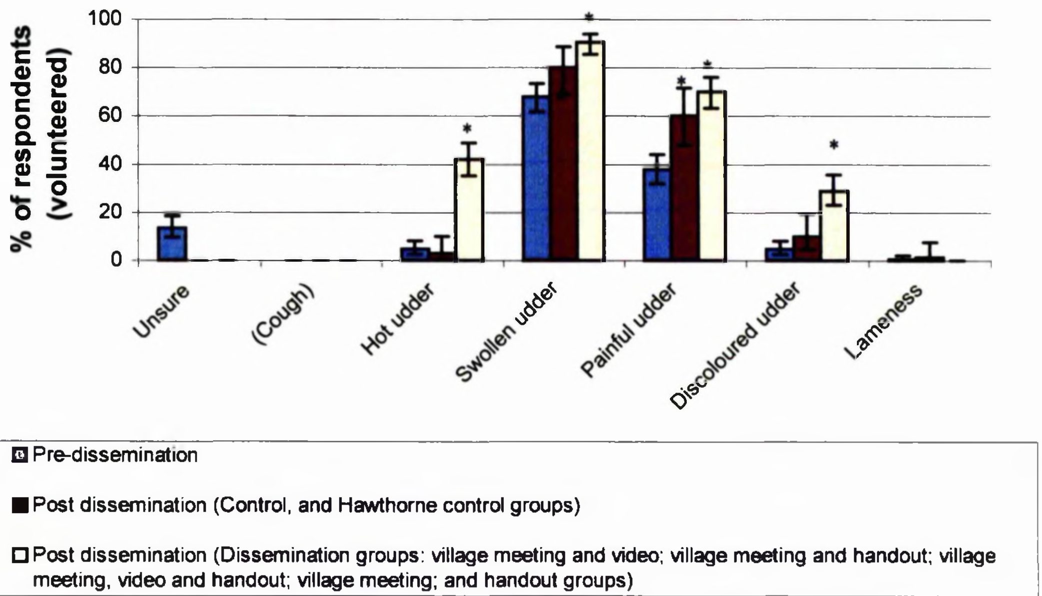


Figure 5-15: 'Signs of mastitis - 1' volunteered responses for three categories of respondents. The exact binomial 95% confidence intervals are shown for each response. Validation variables are shown in brackets. * indicates a significant difference compared to the control group.

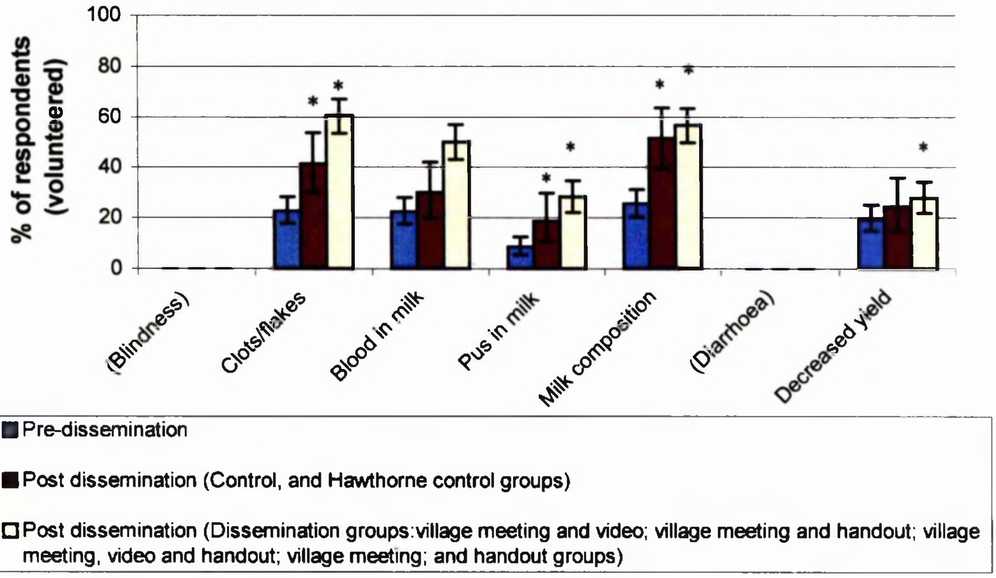


Figure 5-16: 'Signs of mastitis - 2' volunteered responses for three categories of respondents. The exact binomial 95% confidence intervals are shown for each response. Validation variables are shown in brackets. * indicates a significant difference compared to the control group.

5.4.2.6 Effects of mastitis

Question = *'What are the possible effects of mastitis ?'*

Prior to dissemination 15.5% of respondents were unsure of the effects of mastitis, however following dissemination respondents in both control groups ($p<0.001$) and dissemination groups ($p<0.0001$) were able to volunteer at least one effect of mastitis. Of note was the fact that prior to dissemination only 0.4% of respondents were able to volunteer that the disease could spread from quarter to quarter, however following dissemination this proportion had risen to 25.2% ($p<0.0001$) of respondents in the dissemination groups. Similarly, prior to dissemination only 1.2% of respondents were able to volunteer that the disease could spread from 'cow to cow', however following dissemination this proportion had risen to 62.4% ($p<0.0001$) of respondents in the dissemination groups (Fig 5-17).

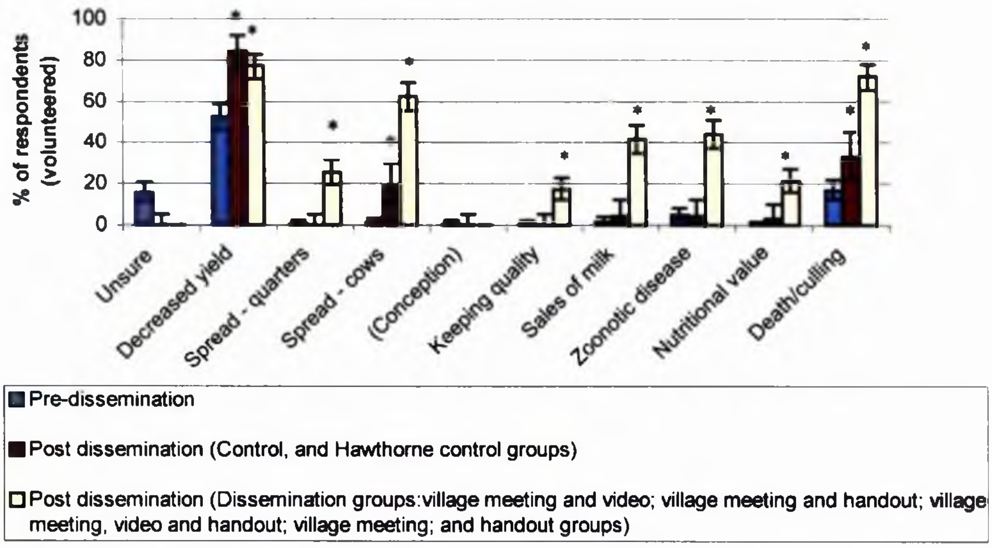


Figure 5-17: 'Effects of mastitis' volunteered responses for three categories of respondents. The exact binomial 95% confidence intervals are shown for each response. Validation variables are shown in brackets. * indicates a significant difference compared to the control group.

5.4.2.7 Spread of mastitis

Question = *'How is mastitis spread ?'*

Prior to the dissemination programme there was extremely poor knowledge amongst respondents about the methods of spread of mastitis, with 35.3% of respondents volunteering that they were unsure how the disease was spread. Following dissemination, however, none of the respondents were unsure about the spread of mastitis, and this change was significant in both the control groups ($p<0.0001$) and the dissemination groups ($p<0.0001$). Prior to dissemination, the two main methods of spread that were volunteered were from 'banda to cow', and from 'incomplete milking'. Following dissemination, however, the proportion of respondents able to volunteer these methods showed a non-significant increase amongst control group respondents, and a significant ($p<0.0001$) increase amongst dissemination group respondents. Of particular note was the fact that only 1.2% of respondents volunteered 'insect to cow' as a method of spread prior to dissemination, however, following dissemination this proportion had increased significantly to 67.1% ($p<0.0001$) amongst dissemination group respondents. Similarly, only 2.0% of respondents volunteered 'udder cloth to cow' as a method of spread prior to dissemination, however, following dissemination this proportion had significantly increased to 58.6% ($p<0.0001$) amongst dissemination group respondents. In addition, following dissemination, over 60% of dissemination group respondents were able to volunteer 'cow to cow' ($p<0.0001$), 'banda to cow' ($P<0.0001$) and 'hands to cow' ($p<0.0001$) as methods of spread of mastitis (Figs 5-18 and 5-19).

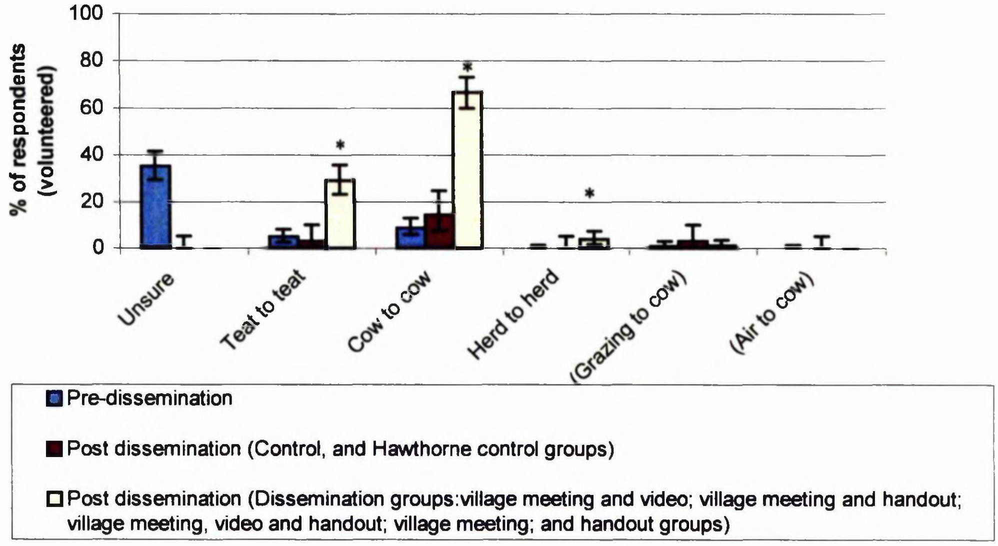


Figure 5-18: 'Spread of mastitis - 1' volunteered responses for three categories of respondents. The exact binomial 95% confidence intervals are shown for each response. Validation variables are shown in brackets. * indicates a significant difference compared to the control group.

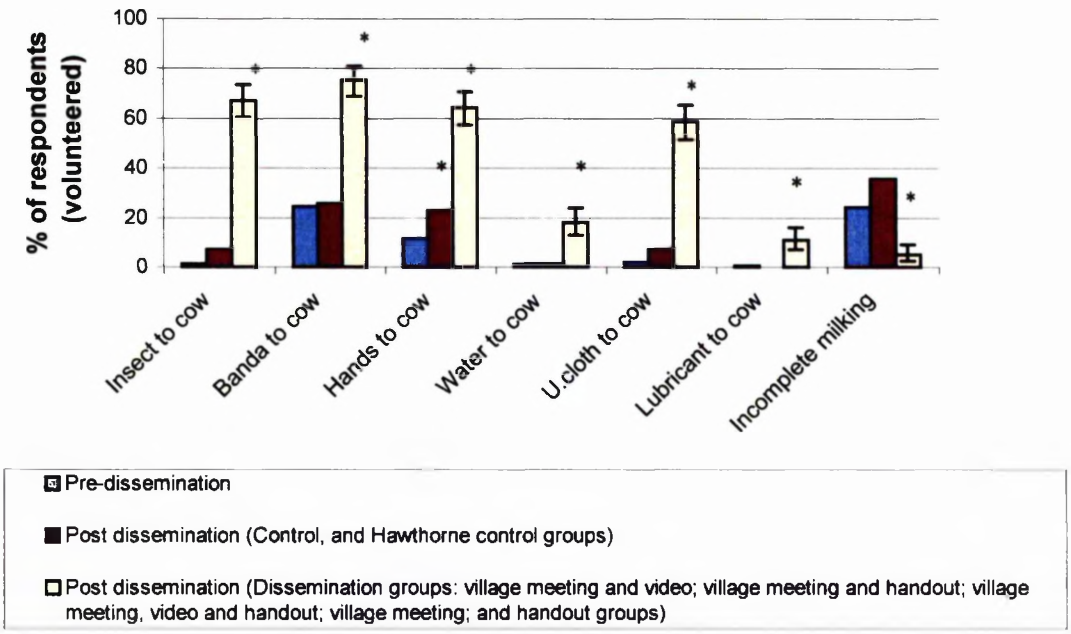


Figure 5-19: 'Spread of mastitis - 2' volunteered responses for three categories of respondents. The exact binomial 95% confidence intervals are shown for each response. * indicates a significant difference compared to the control group.

5.4.2.8 Prevention of mastitis

Question = *'What steps would you take to prevent or control mastitis ?'*

Prior to the dissemination programme there was poor knowledge amongst respondents about the methods of prevention of mastitis, with 17.5% of respondents volunteering that they were unsure of how to prevent the disease. The main methods of prevention volunteered prior to dissemination were 'hygiene of the banda', 'hygiene of the milker' and 'complete milking'.

Following dissemination, the proportion of respondents able to volunteer methods of prevention of mastitis had increased very slightly amongst 'Control' and 'Hawthorne control' groups, but had increased considerably amongst dissemination groups which had received project training. Of particular note was the fact that 26.2% of respondents volunteered 'hygiene of banda' as a method of prevention prior to dissemination, however, following dissemination this proportion had increased to 81.0% ($p<0.0001$) in the dissemination groups. Similarly only 0.8% of respondents volunteered 'hygiene of the udder cloth' as a method of prevention prior to dissemination, however, following dissemination this proportion had risen to 48.1% ($p<0.0001$) in the dissemination groups. In addition, prior to dissemination only 0.8% of respondents were able to volunteer 'using one cloth per cow', 1.2% were able to volunteer 'discarding milk safely' and no respondents were able to volunteer 'using one corner of the cloth per quarter' as methods of prevention of mastitis, however following dissemination a significant increase ($p<0.0001$) was seen, with over 30% of dissemination group respondents able to volunteer these facts.

The most commonly volunteered method of prevention prior to dissemination was 'complete milking' with 28.6% of respondents, however following dissemination this proportion had significantly decreased ($p<0.0001$) to 12.9% amongst respondents in dissemination groups (Figures 5-20, 5-21, and 5-22).

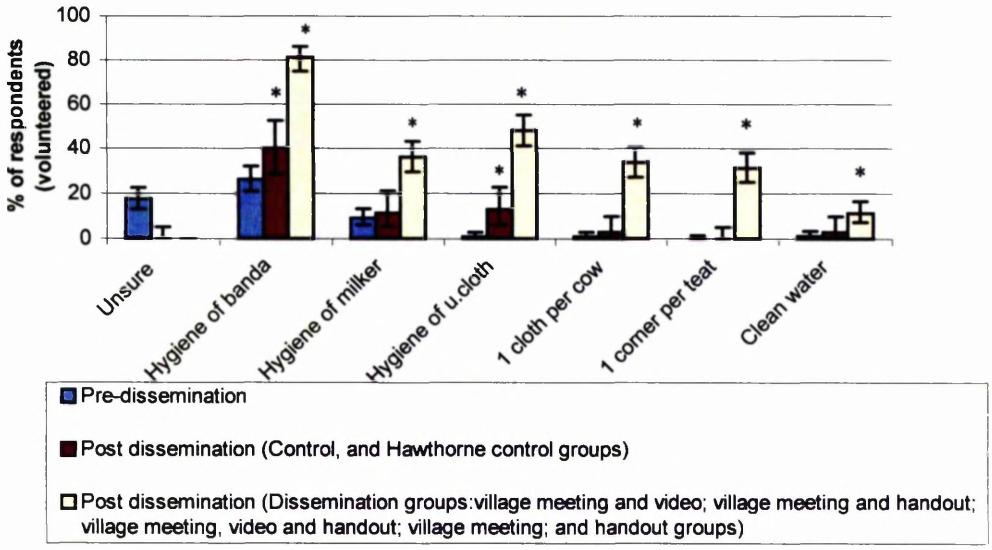


Figure 5-20: 'Prevention of mastitis - 1' volunteered responses for three categories of respondents. The exact binomial 95% confidence intervals are shown for each response. * indicates a significant difference compared to the control group.

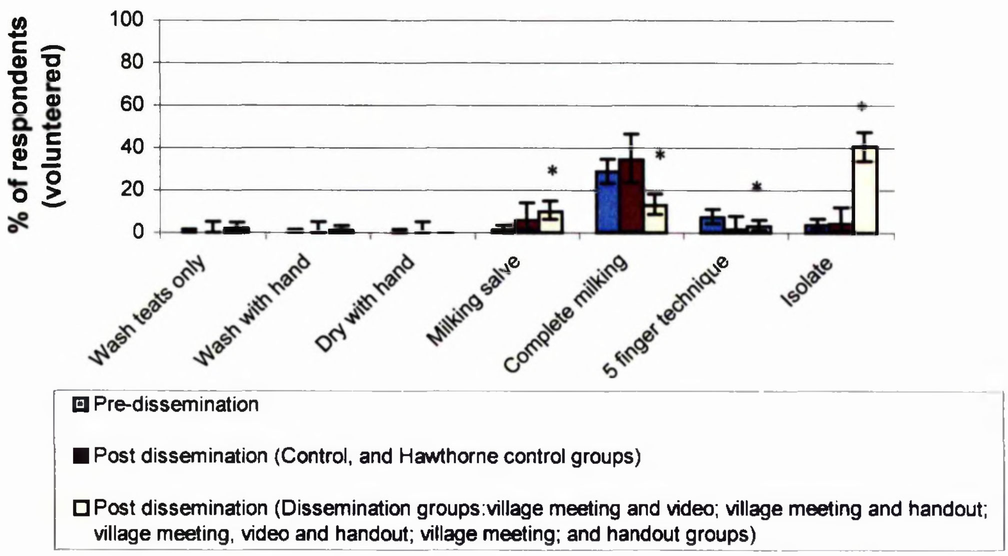


Figure 5-21: 'Prevention of mastitis - 2' volunteered responses for three categories of respondents. The exact binomial 95% confidence intervals are shown for each response. * indicates a significant difference compared to the control group

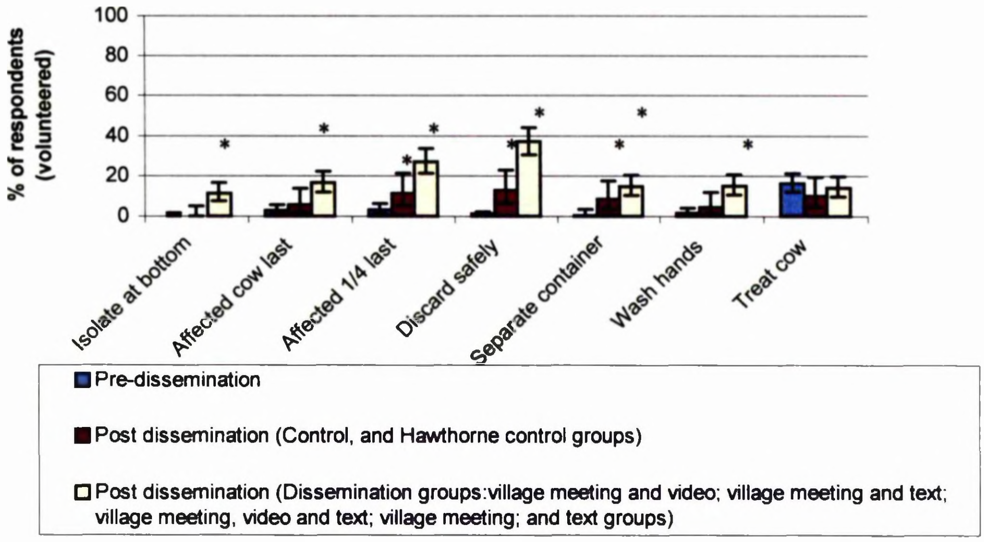


Figure 5-22: 'Prevention of mastitis - 3' volunteered responses for three categories of respondents. The exact binomial 95% confidence intervals are shown for each response. * indicates a significant difference compared to the control group.

5.4.3 Change in knowledge of individuals: pre- and post-dissemination scores

Following completion of both the pre- and post-dissemination questionnaires, an overall pre-and post-dissemination 'score' was allocated to each individual according to the number of mastitis facts volunteered. Each mastitis fact volunteered by a respondent was allocated one point. These pre- and post-dissemination scores were then grouped by village type and dissemination method, and plotted graphically to give an illustration of the change in knowledge for each individual respondent.

Statistical significance is not illustrated in the following figures as the 'difference between pre- and post-dissemination scores' is further analysed by multilevel statistical modelling, which is shown in section 5.3.4.3, however, figures illustrating the change in scores of individual respondents are shown on the following pages.

5.4.3.1 'Control' method

Respondents in villages assigned the 'control' method showed little change between their pre- and post-dissemination scores, with an overall average change in score of 2.7 points. Consideration of the village classification showed an average change in score of 2.7 points for respondents in urban villages, 3.6 points for respondents in peri-urban villages, and 1.9 points for respondents in rural villages. In general, most respondents achieved a higher post-dissemination score than pre-dissemination score, with the exception of one respondent in Shebomeza whose pre-dissemination score was 16 points, and post-dissemination score was 12 points (Fig 5-23).

5.4.3.2 'Village meeting and video' method

Respondents in villages assigned the 'village meeting and video' method showed a change between their pre- and post-dissemination scores, with an overall average change in score of 15.6 points. Consideration of the village classification showed an average change in score of 16.5 points for respondents in urban villages, 17.8 points for respondents in peri-urban villages, and 12.7 points for respondents in rural villages. All respondents achieved a higher post-dissemination score than pre-dissemination score (Fig 5-24).

‘Control’ method

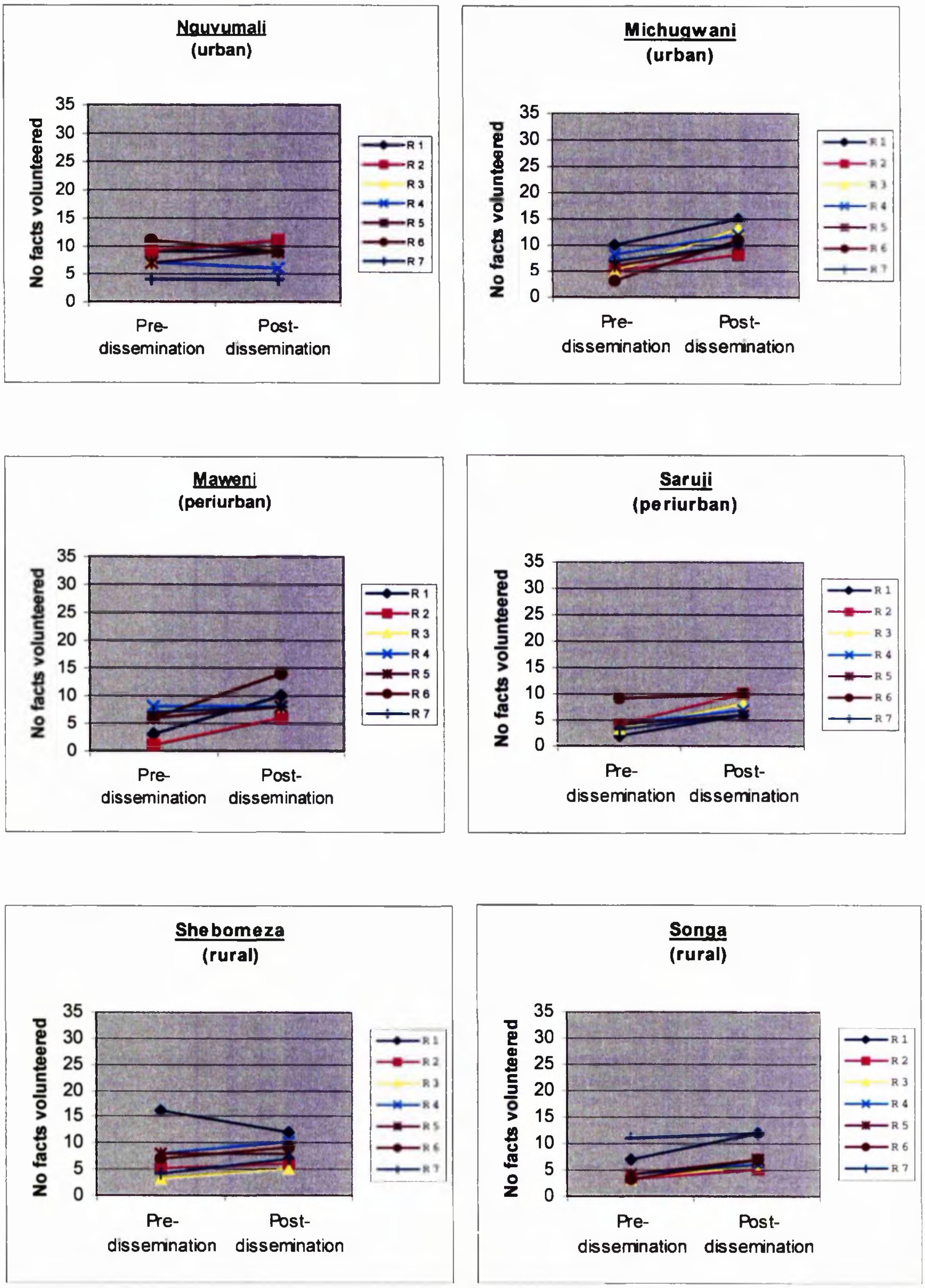


Figure 5-23: The number of facts volunteered pre- and post-dissemination by individual respondents within the six villages assigned the ‘control’ method of dissemination. Within each village, R1=respondent 1, R2=respondent 2, R3=respondent 3, R4=respondent 4, R5=respondent 5, R6=respondent 6, R7=respondent 7. The classification of each village is shown in brackets.

'Village meeting and video' method

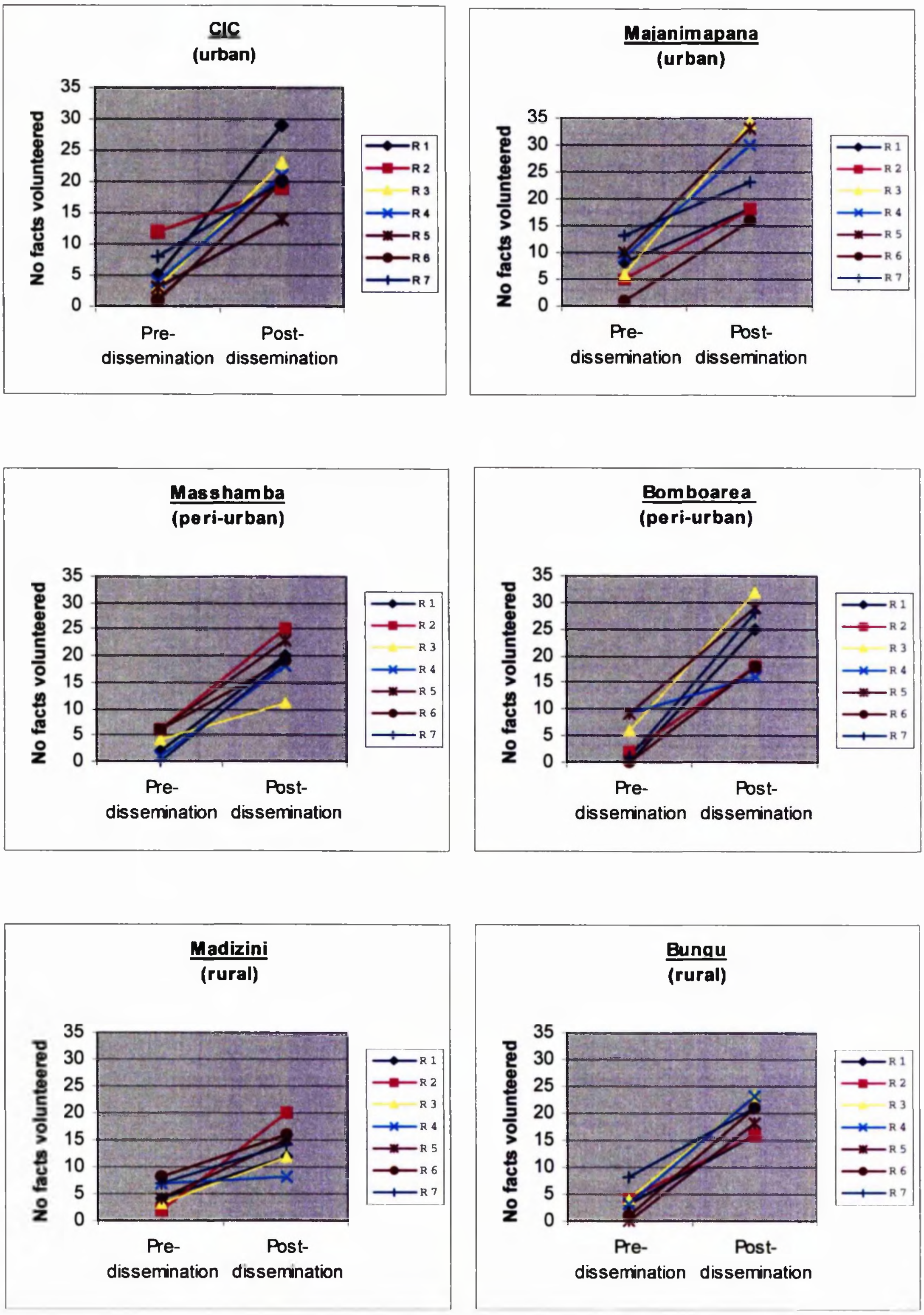


Figure 5-24: The number of facts volunteered pre- and post-dissemination by individual respondents within the six villages assigned the 'village meeting and video' method of dissemination. Within each village, R1=respondent 1, R2=respondent 2, R3=respondent 3, R4=respondent 4, R5=respondent 5, R6=respondent 6, R7=respondent 7. The classification of each village is shown in brackets.

5.4.3.3 'Handout' method

Respondents in villages assigned the 'handout' method showed a change between their pre- and post-dissemination scores, with an overall average change in score of 14.7 points. Consideration of the village classification showed an average change in score of 14.0 points for respondents in urban villages, 15.1 points for respondents in peri-urban villages, and 15.0 points for respondents in rural villages. All respondents achieved a higher post-dissemination score than pre-dissemination score (Fig 5-25).

5.4.3.4 'Village meeting, video and handout' method

Respondents in villages assigned the 'village meeting, video and handout' method showed a change between their pre- and post-dissemination scores, with an overall average change in score of 13.9 points. Consideration of the village classification showed an average change in score of 12.4 points for respondents in urban villages, 16.7 points for respondents in peri-urban villages, and 12.6 points for respondents in rural villages. All respondents achieved a higher post-dissemination score than pre-dissemination score (Fig 5-26).

'Handout' method

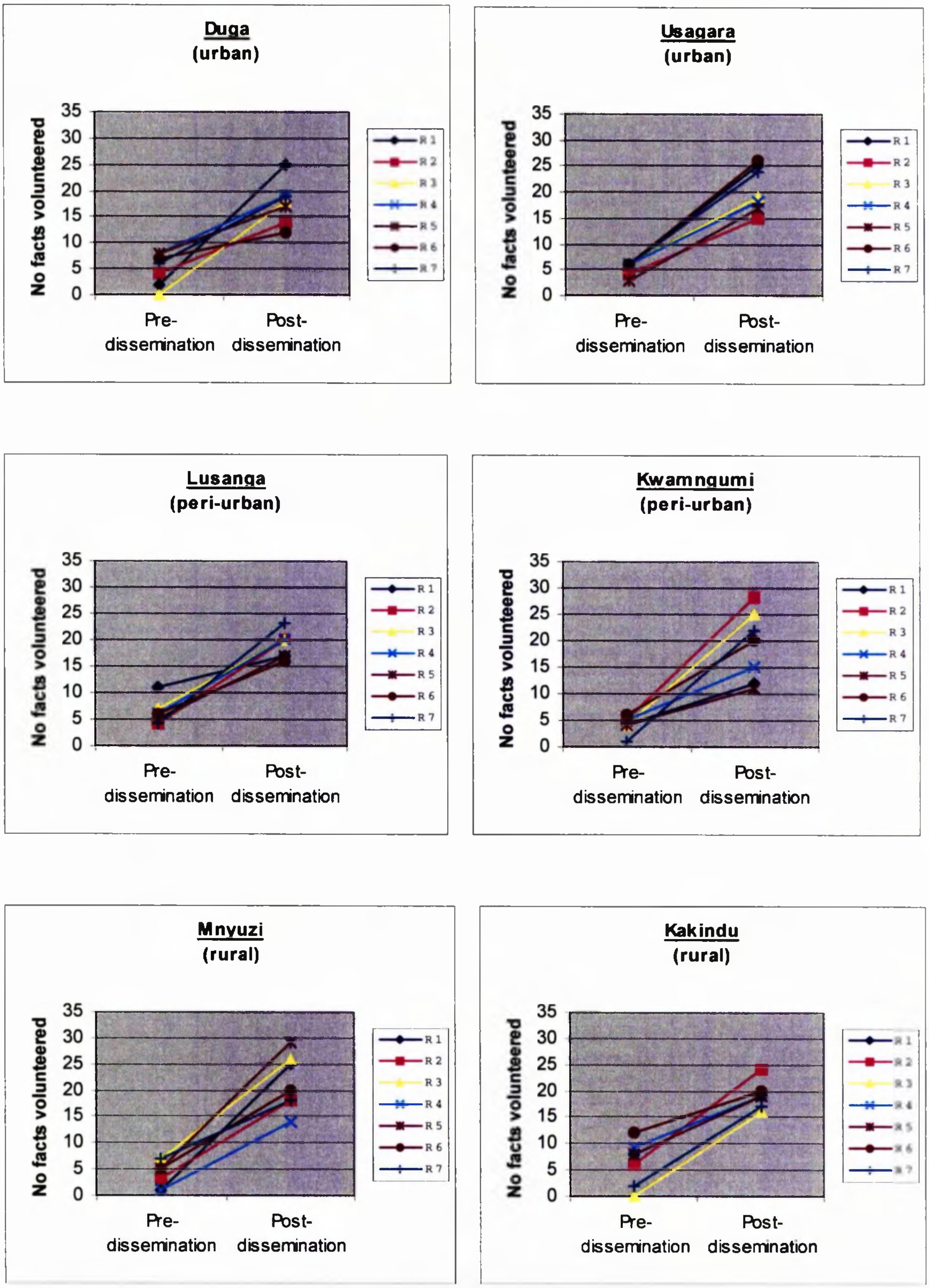


Figure 5-25: The number of facts volunteered pre- and post-dissemination by individual respondents within the six villages assigned the 'handout' method of dissemination. Within each village, R1=respondent 1, R2=respondent 2, R3=respondent 3, R4=respondent 4, R5=respondent 5, R6=respondent 6, R7=respondent 7. The classification of each village is shown in brackets.

'Village meeting, video and handout' method

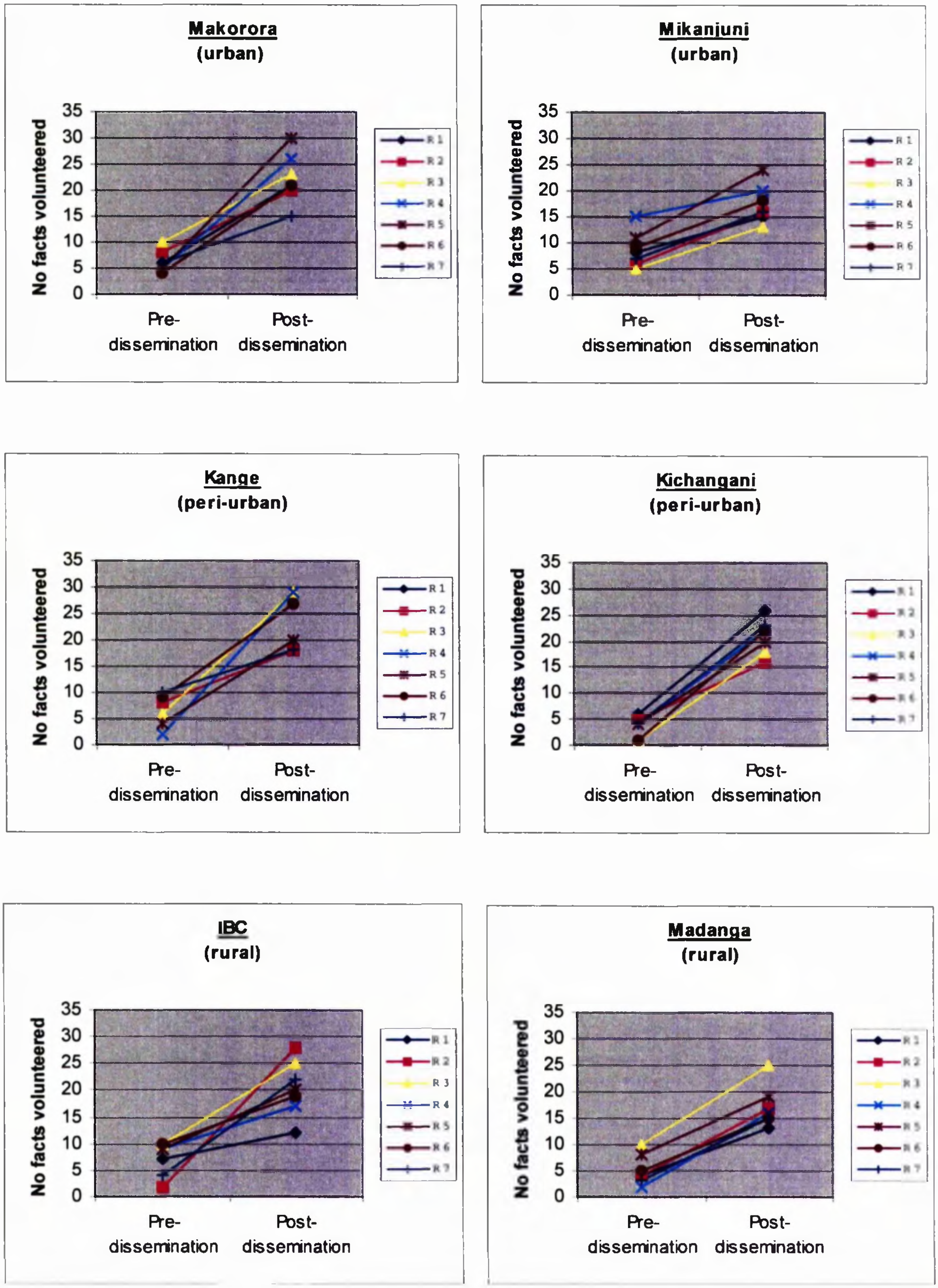


Figure 5-26: The number of facts volunteered pre- and post-dissemination by individual respondents within the six villages assigned the 'village meeting, video and handout' method of dissemination. Within each village, R1=respondent 1, R2=respondent 2, R3=respondent 3, R4=respondent 4, R5=respondent 5, R6=respondent 6, R7=respondent 7. The classification of each village is shown in brackets.

5.4.3.5 'Village meeting and handout' method

Respondents in villages assigned the 'Village meeting and handout' method showed a change between their pre- and post-dissemination scores, with an overall average change in score of 13.8 points. Consideration of the village classification showed an average change in score of 13.4 points for respondents in urban villages, 13.3 points for respondents in peri-urban villages, and 14.7 points for respondents in rural villages. All respondents achieved a higher post-dissemination score than pre-dissemination score (Fig 5-27).

5.4.3.6 'Village meeting' method

Respondents in villages assigned the 'Village meeting' method showed a change between their pre- and post-dissemination scores, with an overall average change in score of 11.2 points. Consideration of the village classification showed an average change in score of 12.5 points for respondents in urban villages, 9.9 points for respondents in peri-urban villages, and 11.3 points for respondents in rural villages. All respondents achieved a higher post-dissemination score than pre-dissemination score (Fig 5-28).

'Village meeting and handout' method

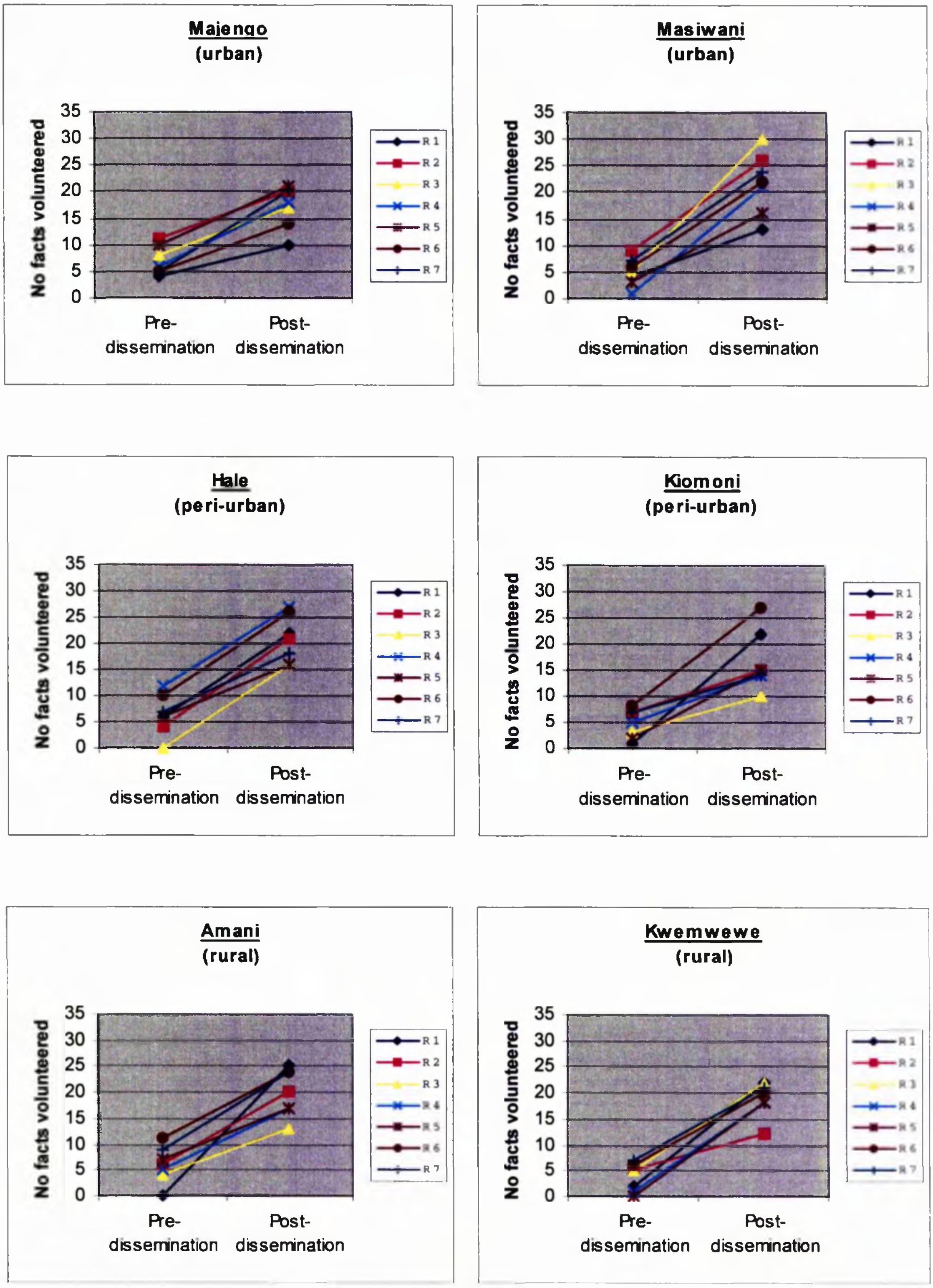


Figure 5-27:The number of facts volunteered pre- and post-dissemination by individual respondents within the six villages assigned the 'village meeting and text' method of dissemination. Within each village, R1=respondent 1, R2=respondent 2, R3=respondent 3, R4=respondent 4, R5=respondent 5, R6=respondent 6, R7=respondent 7. The classification of each village is shown in brackets.

'Village meeting' method

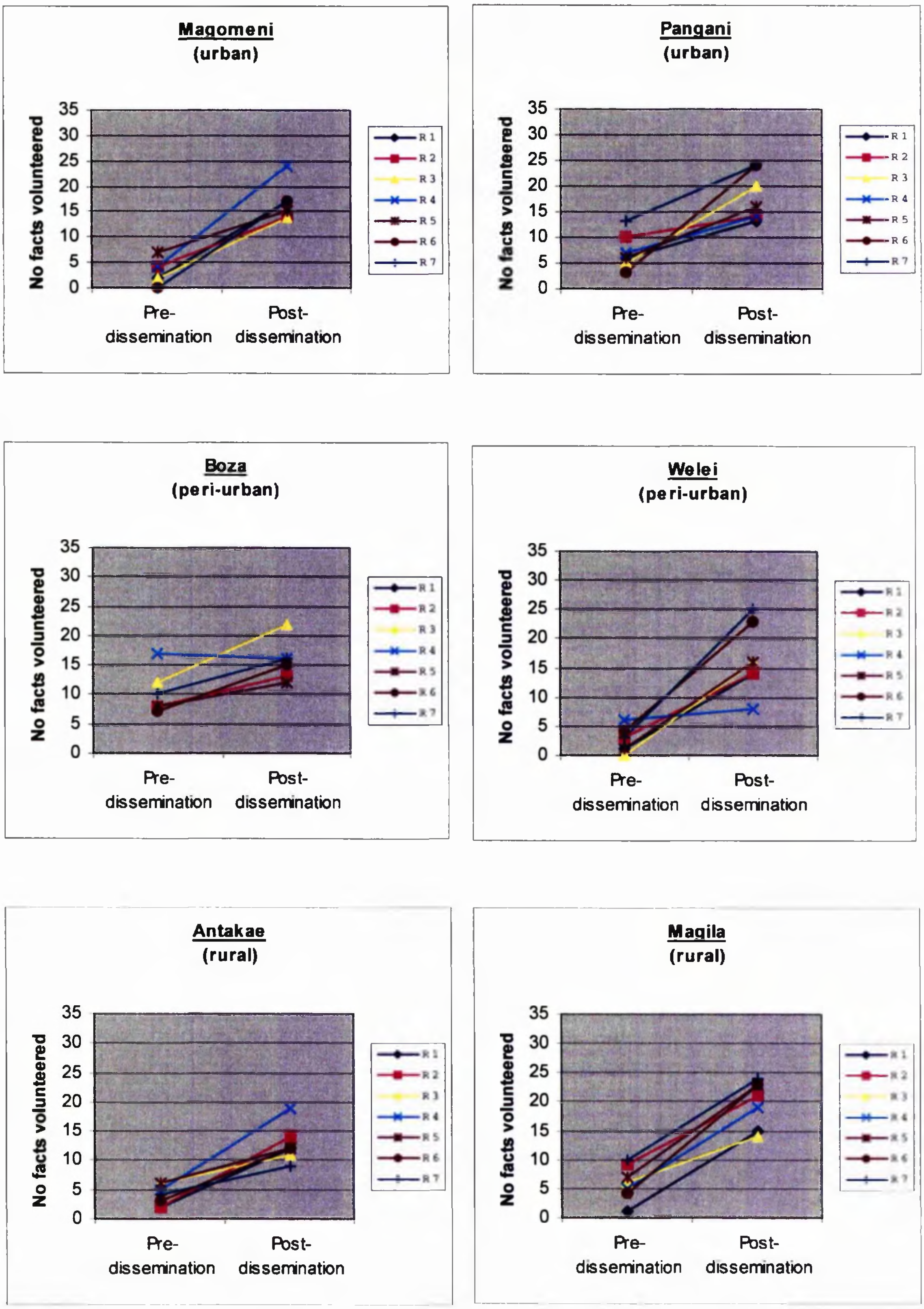


Figure 5-28: The number of facts volunteered pre- and post-dissemination by individual respondents within the six villages assigned the 'village meeting' method of dissemination. Within each village, R1=respondent 1, R2=respondent 2, R3=respondent 3, R4=respondent 4, R5=respondent 5, R6=respondent 6, R7=respondent 7. The classification of each village is shown in brackets.

5.4.4 Statistical Modelling

Analysis was carried out using statistical models to investigate the impact of dissemination, in order to assess variables associated with respondents' overall mastitis knowledge, and change in mastitis knowledge. Odds ratios were obtained using logistic regression models incorporating village as a random effect, and were then illustrated using horizontal error bars.

Two different multilevel models were used to assess the 'overall mastitis knowledge of a respondent', defined as 'volunteering a correct mastitis fact post-dissemination'. The first model assessed the contribution of individual question, farm and village to the overall variation (Model 1), whilst the second assessed the contribution of individual question, question number and question type to the overall variation (Model 2). Individual question level (level 1) refers to an individual respondent being asked an individual question, whilst question type (level 3) refers to the category of question e.g. identification of mastitis, or signs of mastitis. A third multilevel model was used to assess the 'change in mastitis knowledge of a respondent', defined as 'the difference between pre- and post-dissemination scores'. This model assessed the contribution of farm and village to the overall variation (Model 3).

5.4.4.1 Odds ratios for post dissemination, volunteered answers

The impact of the different dissemination methods was assessed for all mastitis facts included on the post-dissemination questionnaire, which included facts associated with the 'identification', 'action taken', 'signs', 'effects', 'spread', and 'prevention' of mastitis.

Figure 5-29 illustrates the odds ratios, and associated confidence intervals obtained for the dissemination of facts concerning the 'identification of mastitis' and 'action taken following the identification of mastitis' by the five dissemination methods ('village meeting and video'; 'handout'; 'village meeting, video and handout'; 'village meeting and handout'; and 'village meeting') and the 'Hawthorne control' group, with reference to the 'control' group.

Throughout this section, figures refer to the project handout as 'text'.

Identification of mastitis

Statistically significant odds ratios were obtained with the method of identification of mastitis **'palpate udder'** when 'village meeting and video' (OR = 11.6); and 'village meeting' (OR = 4.5) were the dissemination methods used (Fig 5-29).

Statistically significant odds ratios were obtained for the method of identification of mastitis **'check foremilk'** when 'village meeting and video' (OR = 8.2); 'village meeting and handout' (OR = 5.6); and 'village meeting, video and handout' (OR = 5.0) were employed (Fig 5-29).

No statistically significant odds ratios were obtained with the method of identification of mastitis **'look at udder'** when any of the dissemination methods or 'Hawthorne control' method were used. (Fig 5-29).

Overall, 'village meeting and video' was the most successful dissemination method, with significant effects for two of the facts associated with the identification of mastitis, 'palpate udder', and 'check foremilk'.

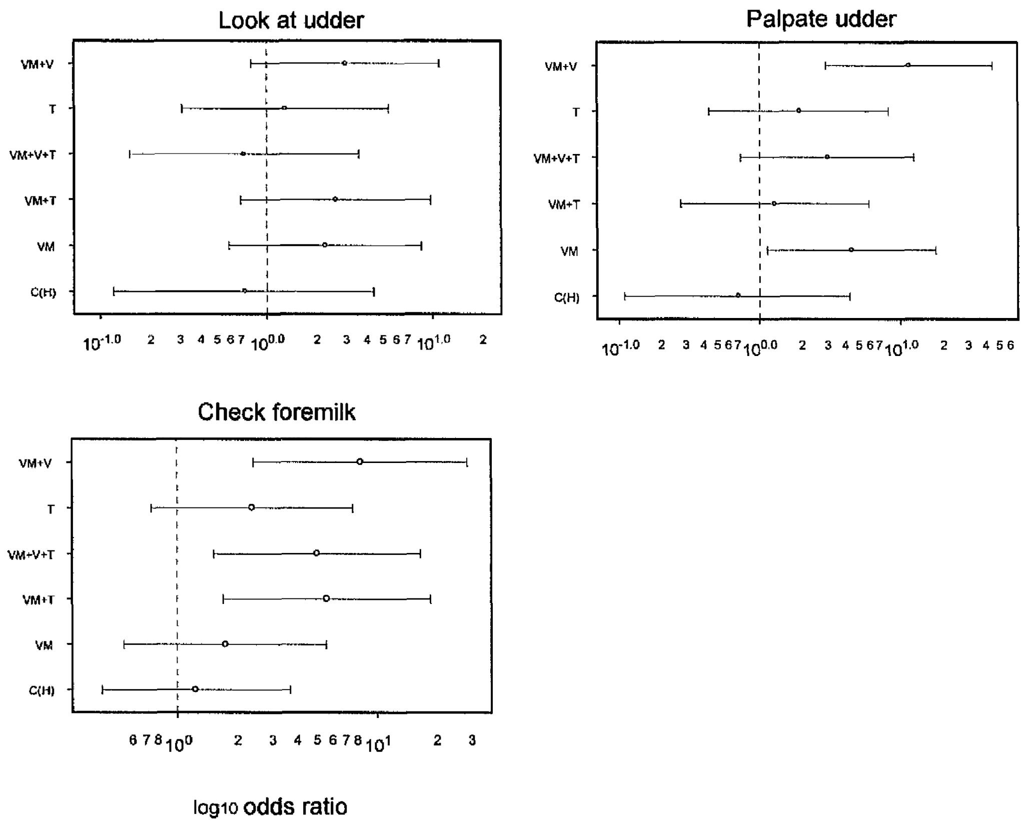
5.4.4.1.1 Action taken following identification of mastitis

Statistically significant odds ratios were obtained with the recommendation of **'increase frequency of milking'** when 'handout' (OR = 16.4) was the dissemination method used (Fig 5-29).

No statistically significant odds ratios were obtained with the recommendation of **'seeking advice'** when any of the five dissemination methods or the 'Hawthorne control' method were used. (Fig 5-29).

Appendix 18 also illustrates the odds ratios, associated confidence intervals and p values for the above findings.

Identification of Mastitis



Action taken following identification of mastitis

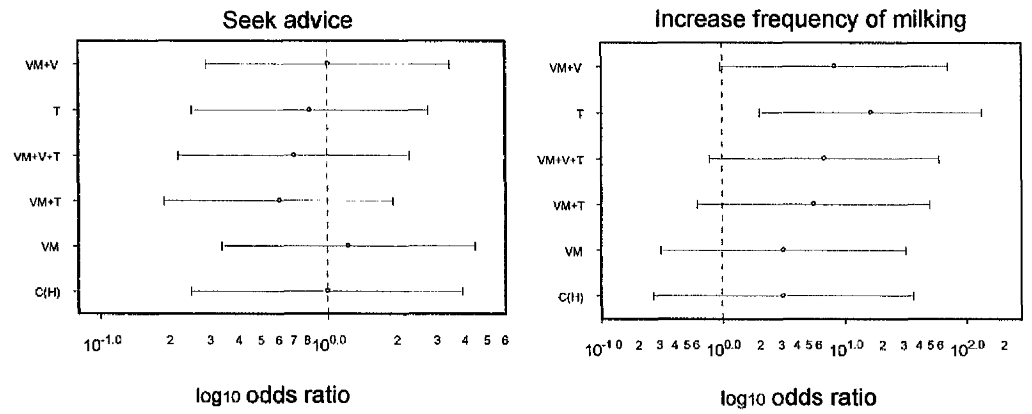


Figure 5-29: Horizontal error bar plots, illustrating odds ratios (represented by circles) plus their associated confidence intervals (represented by horizontal error bars) for the dissemination of facts concerning the 'identification of mastitis' and 'action taken following the identification of mastitis' by the different dissemination methods [VM+V = village meeting and video; T = text; VM+V+T = village meeting, video and text; VM+T = village meeting and text; VM = village meeting; C(H) = 'Hawthorne' control method] with reference to the control group. A vertical reference line is plotted at point '$\log_{10}0$' (equivalent to the point '1' on a linear scale) which, if crossed by the associated confidence intervals, illustrates that the odds ratio is not statistically significant. 'Text' refers to the project diagrammatic handout.

Signs of mastitis

Figures 5-30 and 5-31 illustrate the odds ratios and associated confidence intervals obtained for the dissemination of facts concerning the 'signs of mastitis' by the five dissemination methods ('village meeting and video'; 'handout'; 'village meeting, video and handout'; 'village meeting and handout'; and 'village meeting'); and the 'Hawthorne effect' control group with reference to the 'control' group.

Statistically significant odds ratios were obtained with the sign of mastitis **'hot udder'** when 'village meeting and video' (OR = 72.8); 'handout' (OR = 22.6); 'village meeting, video and handout' (OR = 59.2); 'village meeting and handout' (OR = 25.4); and 'village meeting' (OR = 15.8) were the dissemination methods used.

Statistically significant odds ratios were obtained with the sign of mastitis **'clots in milk'** when 'village meeting and video' (OR = 2.9); 'handout' (OR = 2.6); 'village meeting, video and handout' (OR = 3.2); and village meeting (OR = 2.9) were the dissemination methods used.

Statistically significant odds ratios were obtained with the sign of mastitis **'discoloured udder'** when 'handout' (OR = 7.5); 'village meeting, video and handout' (OR = 6.7); and 'village meeting and handout' (OR = 6.0) were the dissemination methods used.

Statistically significant odds ratios were obtained with the sign of mastitis **'painful udder'** only when 'handout' (OR = 4.5) was the dissemination method used (Fig 5-31), and for the sign of mastitis **'blood in milk'** only when 'village meeting and video' (OR = 3.6); was the dissemination method used.

No statistically significant odds ratios were obtained for the signs of mastitis **'swollen udder', 'pus in milk', 'altered milk composition',** or **'decreased milk yield'** for any of the dissemination methods used.

'Village meeting and video' was the most effective method of dissemination for the signs of mastitis **'hot udder'** and **'blood in milk'**. 'Handout' was the most effective method of dissemination for the signs of mastitis **'painful udder' and 'discoloured udder'.** 'Village meeting, video and handout' was the most effective method of dissemination for the sign of mastitis **'clots in milk'**.

Overall, there was marked variation in the effectiveness of methods of dissemination for facts concerning 'signs of mastitis'. In general, the 'handout', and 'village meeting and video' methods of dissemination were found to be most successful.

Appendix 18 also illustrates the odds ratios, associated confidence intervals and p values for these findings.

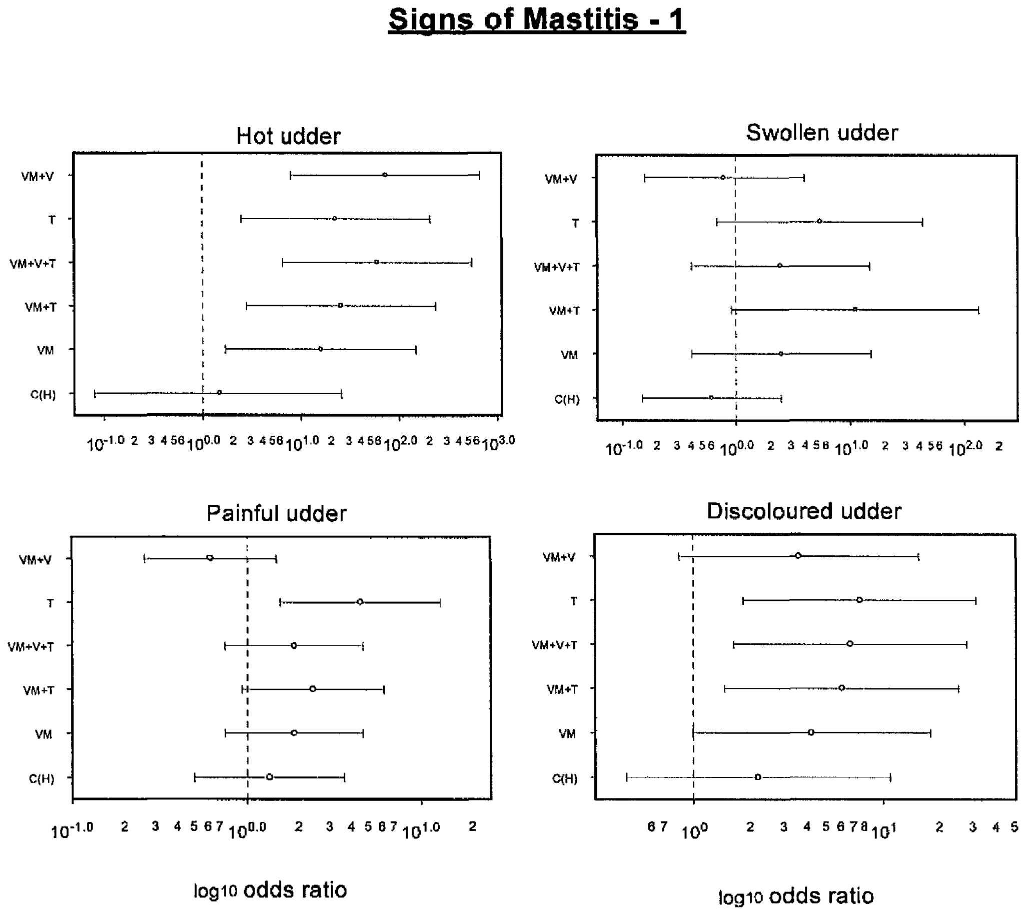


Figure 5-30: Horizontal error bar plots, illustrating odds ratios (represented by circles) plus their associated confidence intervals (represented by horizontal error bars) for the dissemination of facts concerning the 'signs of mastitis' by the different dissemination methods [VM+V = village meeting and video; T = text; VM+V+T = village meeting, video and text; VM+T = village meeting and text; VM = village meeting; C(H) = 'Hawthorne' control method] with reference to the control group. A vertical reference line is plotted at point '$\log_{10}0$' (equivalent to the point '1' on a linear scale) which, if crossed by the associated confidence intervals, illustrates that the odds ratio is not statistically significant. "Text" refers to the project handout.

Signs of Mastitis - 2

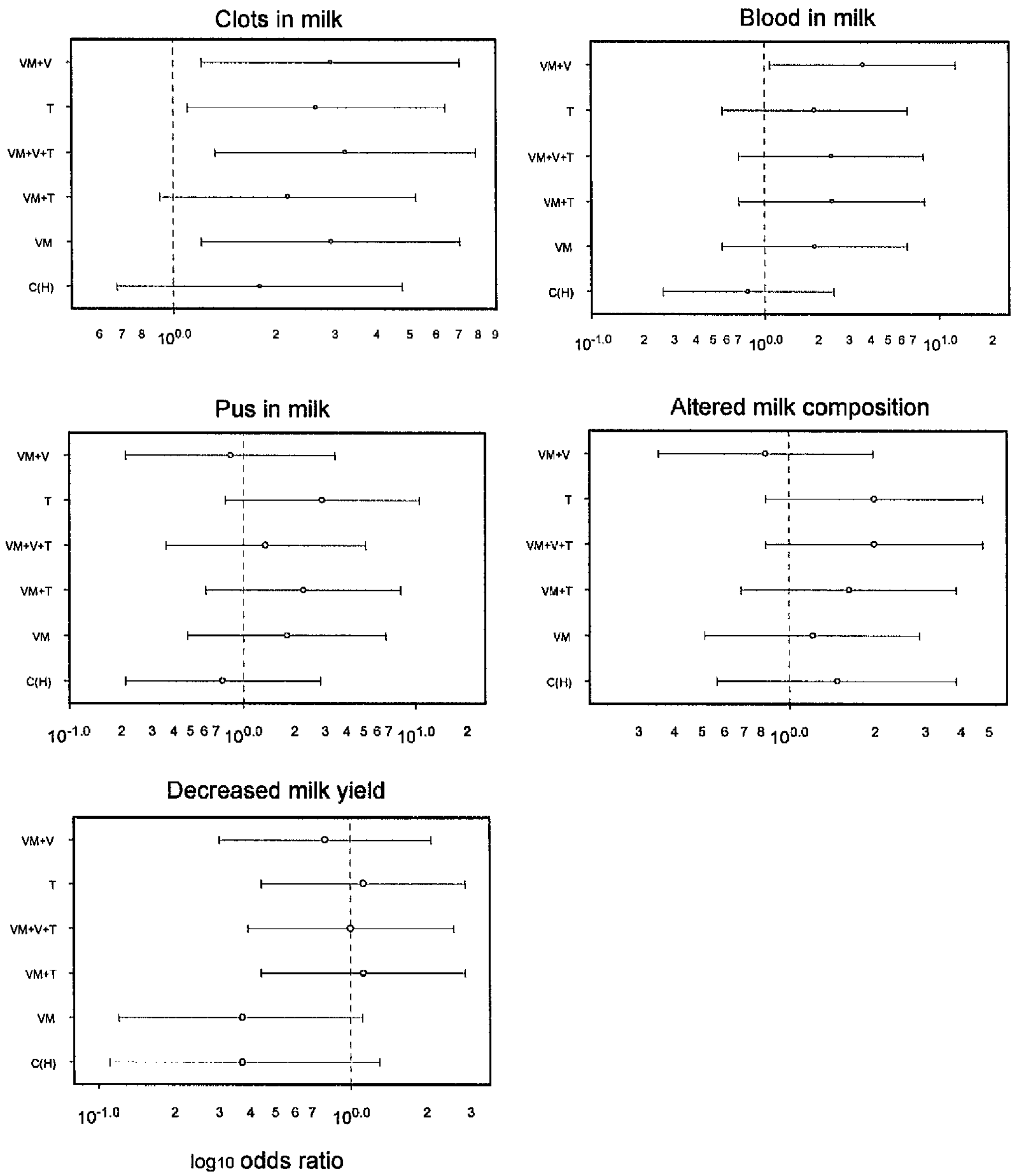


Figure 5-31: Horizontal error bar plots, illustrating odds ratios (represented by circles) plus their associated confidence intervals (represented by horizontal error bars) for the dissemination of facts concerning the 'signs of mastitis' by the different dissemination methods (VM+V = village meeting and video; T = text; VM+V+T = village meeting, video and text; VM+T = village meeting and text; VM = village meeting; C(H) = 'Hawthorne' control method) with reference to the control group. A vertical reference line is plotted at point '$\log_{10}0$' (equivalent to the point '1' on a linear scale) which, if crossed by the associated confidence intervals, illustrates that the odds ratio is not statistically significant. 'Text' refers to the project handout.

Effects of mastitis

Figure 5-32 illustrates the odds ratios and associated confidence intervals obtained for the dissemination of facts concerning the 'effects of mastitis' by the five dissemination methods ('village meeting and video'; 'handout; 'village meeting, video and handout'; 'village meeting and handout'; and 'village meeting') and the 'Hawthorne effect' control group, with reference to the control group.

Statistically significant odds ratios were obtained with the effect of mastitis **'spread to other cows'** when 'village meeting and video' (OR = 8.6); 'handout' (OR = 9.6); 'village meeting, video and handout' (OR = 9.6); 'village meeting and handout' (OR = 6.3); and 'village meeting' (OR = 3.9) were the dissemination methods used

Statistically significant odds ratios were obtained with the effect of mastitis **'milk being rejected for sale'** when 'village meeting and video' (OR = 28.2); 'handout' (OR = 50.5); 'village meeting, video and handout' (OR = 20.7), 'village meeting and handout' (OR = 28.2); and village meeting (OR = 25.5) were the dissemination methods used

Statistically significant odds ratios were obtained with the effect of mastitis **'risk of zoonotic disease from drinking infected milk'** when 'village meeting and video' (OR = 16.9); 'handout' (OR = 12.1); 'village meeting, video and handout' (OR = 22.9); 'village meeting and handout' (OR = 18.7); and village meeting (OR = 18.6) were the dissemination methods used.

Statistically significant odds ratios were obtained with the effect of mastitis **'death of the cow'** when 'village meeting and video' (OR = 3.8); 'handout' (OR = 5.5); 'village meeting, video and handout' (OR = 4.2); and 'village meeting and handout' (OR = 10.4) were the dissemination methods used

A statistically significant odds ratio was obtained with the effect of mastitis **'decreased milk yield'** for the 'Hawthorne control' method (OR = 0.2), which represents a 'negative effect of dissemination'.

Odds ratios were not obtained for the effects of mastitis **'spread to other quarters'**, **'decreased nutritional value'**, and **'decreased keeping quality of milk'** due to a lack of convergence of data during analysis.

There was good evidence of effectiveness of dissemination methods in increasing respondent's knowledge about the 'effects of mastitis'. Three of the effects of mastitis ('spread to other cows', 'milk rejected for sale', and 'risk of zoonotic disease') showed a significant association with all five dissemination methods but not with the 'Hawthorne control' method. A further effect of mastitis, 'death of cow' showed a significant association with four of the methods of dissemination, namely 'village meeting and video'; 'handout'; 'village meeting, video and handout'; and 'village meeting and handout'.

'Village meeting and handout' was the most successful method of dissemination for the effect of mastitis **'death of cow'**. 'Village meeting, video and handout' was the most successful method of dissemination for the effects of mastitis **'spread to other cows'** and **'risk of zoonotic disease'**. The 'handout' method was the most successful method of dissemination for the effects of mastitis **'spread to other cows'** and **'milk rejected for sale'.**

Overall, 'village meeting, video and handout', and 'handout' were found to be the most effective methods of dissemination (relative to the control group), with both being the most effective methods for two out of the five effects of mastitis.

Appendix 18 also illustrates the odds ratios, associated confidence intervals and p values for the above findings.

Effects of Mastitis

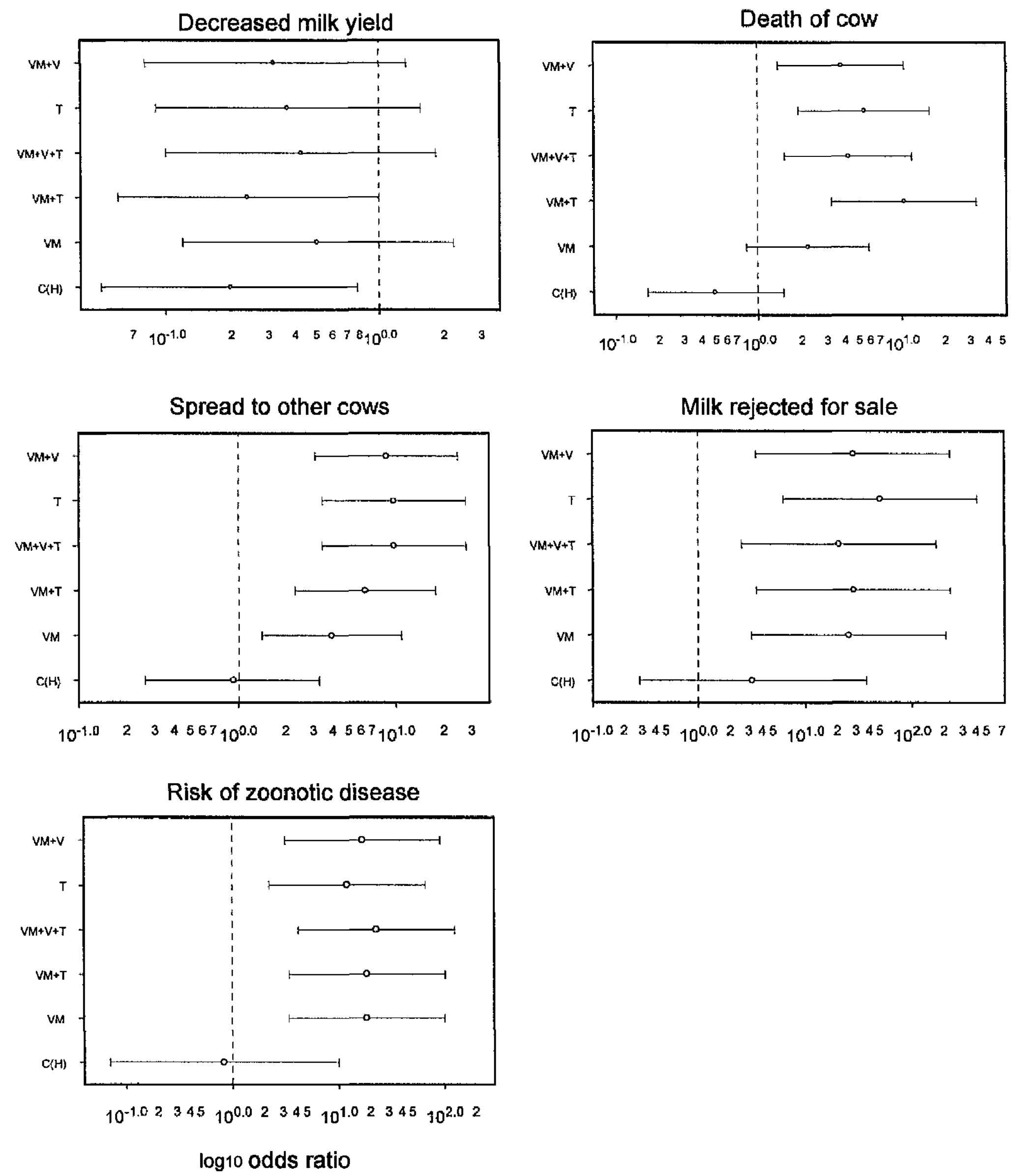


Figure 5-32: Horizontal error bar plots, illustrating odds ratios (represented by circles) plus their associated confidence intervals (represented by horizontal error bars) for the dissemination of facts concerning the 'effects of mastitis' by the different dissemination methods (VM+V=village meeting and video; T=text; VM+V+T=village meeting, video and text; VM+T=village meeting and text; VM=village meeting; C(H)='Hawthorne' control method) with reference to the control group. A vertical reference line is plotted at point '$\log_{10}0$' (equivalent to the point '1' on a linear scale) which, if crossed by the associated confidence intervals, illustrates that the odds ratio is not statistically significant. 'Text' refers to the project handout.

Spread of mastitis

Figures 5-33 and 5-34 illustrate the odds ratios and associated confidence intervals obtained for the dissemination of facts concerning the 'spread of mastitis' by the five dissemination methods ('village meeting and video'; 'handout'; 'village meeting, video and handout'; 'village meeting and handout'; and 'village meeting'); and the 'Hawthorne control' group, with reference to the 'control' group.

Statistically significant odds ratios were obtained with the method of spread of mastitis **'from teat to teat'** when 'village meeting and video' (OR = 22.8); 'handout' (OR = 14.5); village meeting, video and handout' (OR = 22.8), village meeting and handout' (OR = 16.4); and village meeting (OR = 9.6) were the dissemination methods used

Statistically significant odds ratios were obtained with the method of spread of mastitis **'from cow to cow'** when 'village meeting and video' (OR = 14.8); 'handout' (OR = 20.9); 'village meeting, video and handout' (OR = 16.5), 'village meeting and handout' (OR = 18.5); and village meeting (OR = 8.1) were the dissemination methods used.

Statistically significant odds ratios were obtained with the method of spread of mastitis **'from insect to cow'** when 'village meeting and video' (OR = 39.1); 'handout' (OR = 20.1); 'village meeting, video and handout' (OR = 51.1), 'village meeting and handout' (OR = 20.1); and 'village meeting' (OR = 24.7) were the dissemination methods used.

Statistically significant odds ratios were obtained with the method of spread of mastitis **'from banda to cow'** when 'village meeting and video' (OR = 16.9); 'handout' (OR = 7.9); 'village meeting, video and handout' (OR = 7.1), 'village meeting and handout' (OR = 6.3); and 'village meeting' (OR = 9.0) were the dissemination methods used.

Statistically significant odds ratios were obtained with the method of spread of mastitis **'from milker's hands to cow'** when 'village meeting and video' (OR = 8.7); 'handout' (OR = 4.1); 'village meeting, video and handout' (OR = 19.8), 'village meeting and handout' (OR = 7.8); and 'village meeting' (OR = 6.3) were the dissemination methods used

Statistically significant odds ratios were obtained with the method of spread of mastitis **'from udder cloth to cow'** when 'village meeting and video' (OR = 41.0); 'handout' (OR = 91.5); 'village meeting, video and handout' (OR = 30.8), 'village meeting and handout' (OR = 150.3); and 'village meeting' (OR = 45.1) were the dissemination methods used.

Statistically significant odds ratios were obtained with the method of spread of mastitis **'from water to cow'** when 'village meeting and video' (OR = 20.1); and 'village meeting, video and handout' (OR = 13.9), were the dissemination methods used.

Odds ratios were not obtained for the methods of spread of mastitis **'from herd to herd'** or **'from teat lubricant to cow'** due to a lack of convergence of data during analysis.

There was good evidence of effectiveness of dissemination methods in increasing respondents' knowledge about the 'spread of mastitis'. Six of the nine methods of spread of mastitis ('from teat to teat, 'from cow to cow', 'from insect to cow', 'from banda to cow', from milkers' hands to cow', and from 'udder cloth to cow') showed a significant association with all five dissemination methods used, and no association with the 'Hawthorne control' group.

The 'village meeting and video' was the most successful dissemination method for the methods of spread of mastitis **'from teat to teat', 'from banda to cow', 'from milker's hands to cow'** and **'from water to cow'.** The 'village meeting, video and handout' method was the most successful for disseminating the methods of spread of mastitis, **'from teat to teat'** and **'from insect to cow'**. The 'handout' method was the most successful for disseminating the method of spread of mastitis, **'from cow to cow'**. 'Village meeting and handout' was the most successful dissemination method for the method of spread of mastitis, **'from udder cloth to cow'**.

Overall, 'village meeting and video' was the most successful method of dissemination, being the most effective for four of the nine methods of spread of mastitis.

Appendix 18 also illustrates the odds ratios, associated confidence intervals and p values for the above findings.

Spread of Mastitis - 1

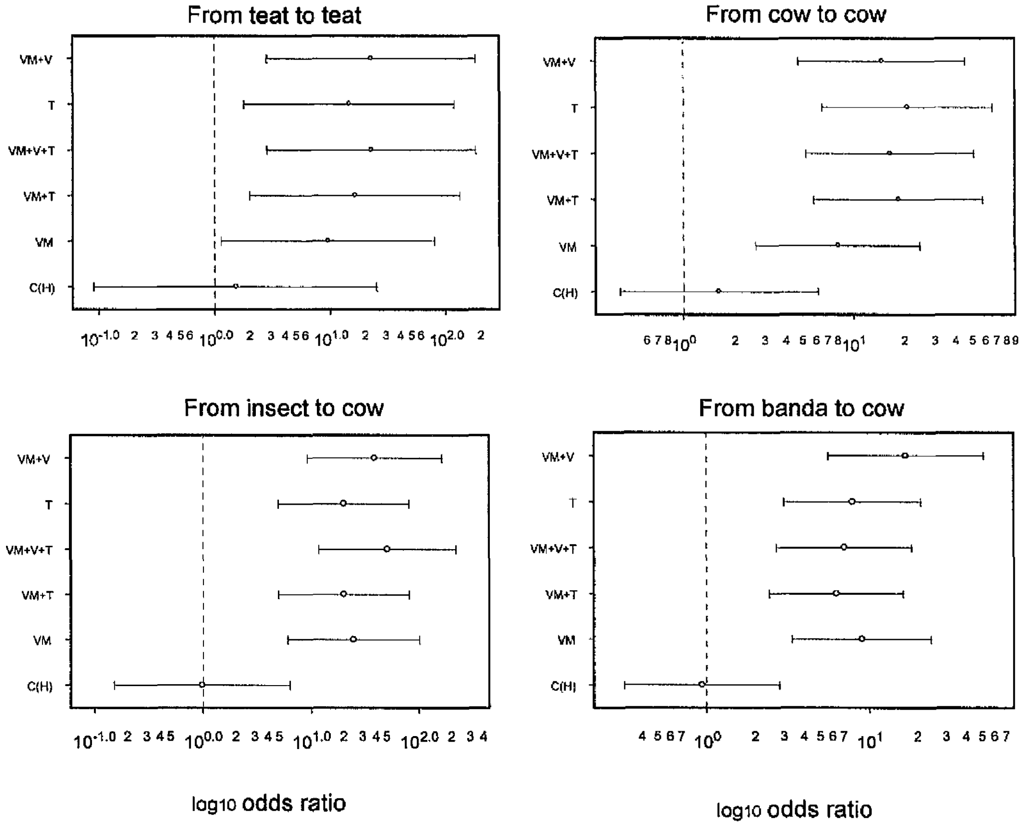


Figure 5-33: Horizontal error bar plots generated in S-plus, illustrating odds ratios (represented by circles) plus their associated confidence intervals (represented by horizontal error bars) for the dissemination of facts concerning the 'spread of mastitis' by the different dissemination methods (VM+V=village meeting and video; T=text; VM+V+T=village meeting, video and text; VM+T=village meeting and text; VM=village meeting; C(H)='Hawthorne' control method) with reference to the control group. A vertical reference line is plotted at point '$log_{10}0$' (equivalent to the point '1' on a linear scale) which, if crossed by the associated confidence intervals, illustrates that the odds ratio is not statistically significant. 'Text' refers to the project handout.

Spread of Mastitis - 2

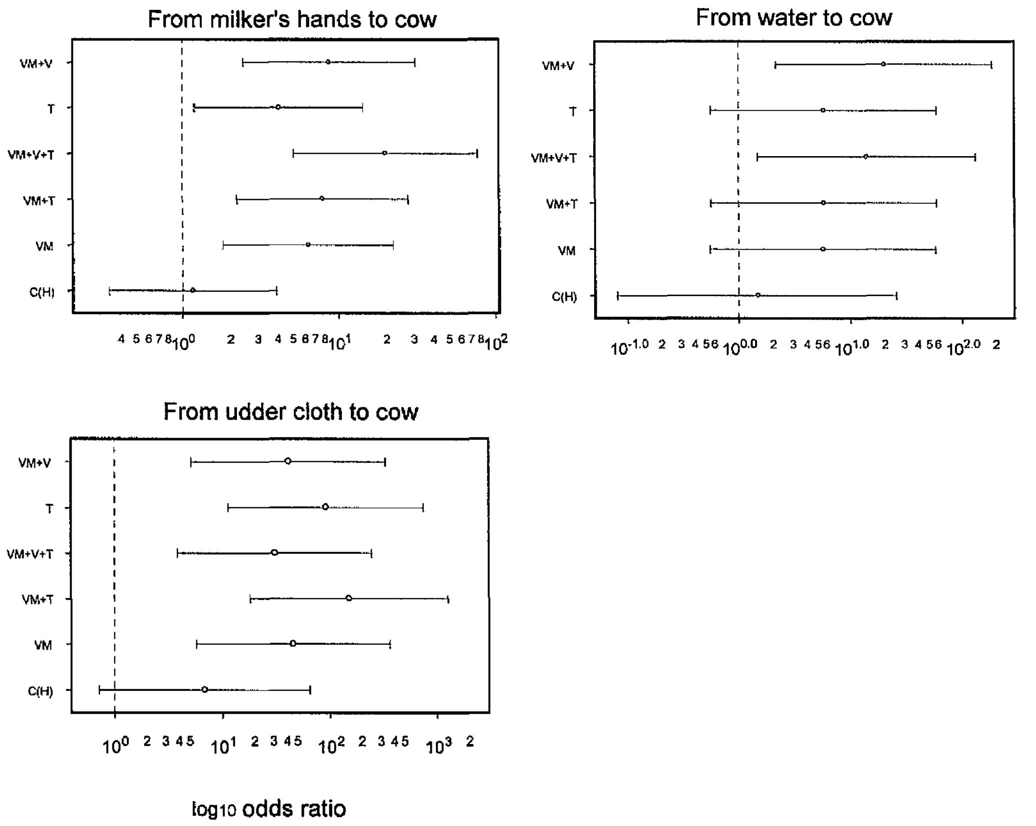


Figure 5-34: Horizontal error bar plots generated in S-plus, illustrating odds ratios (represented by circles) plus their associated confidence intervals (represented by horizontal error bars) for the dissemination of facts concerning the 'spread of mastitis' by the different dissemination methods (VM+V=village meeting and video; T=text; VM+V+T=village meeting, video and text; VM+T=village meeting and text; VM=village meeting; C(H)='Hawthorne' control method) with reference to the control group. A vertical reference line is plotted at point '$\log_{10}0$' (equivalent to the point '1' on a linear scale) which, if crossed by the associated confidence intervals, illustrates that the odds ratio is not statistically significant. 'Text' refers to the project handout.

5.4.4.1.2 Prevention of mastitis

Figures 5-35, 5-36 and 5-37 illustrate the odds ratios and associated confidence intervals obtained for the dissemination of facts concerning the 'prevention of mastitis' by the five dissemination methods ('village meeting and video'; 'handout'; 'village meeting, video and handout'; 'village meeting and handout'; and 'village meeting') and the 'Hawthorne control' group, with reference to the control group.

Statistically significant odds ratios were obtained with the method of prevention of mastitis **'good hygiene of banda'** when 'village meeting and video' (OR = 6.9); 'handout' (OR = 9.8); 'village meeting, video and handout' (OR = 6.9), 'village meeting and handout' (OR = 5.2); and 'village meeting' (OR = 6.9) were the dissemination methods used.

Statistically significant odds ratios were obtained with the method of prevention of mastitis **'good hygiene of udder cloth'** when 'village meeting and video' (OR = 7.2); 'handout' (OR = 9.7); 'village meeting, video and handout' (OR = 5.9), 'village meeting and handout' (OR = 13.2); and 'village meeting' (OR = 3.8) were the dissemination methods used.

Statistically significant odds ratios were obtained with the method of prevention of mastitis **'discard affected milk safely'** when 'village meeting and video' (OR = 4.3); 'handout' (OR = 6.6); 'village meeting, video and handout' (OR = 4.8), 'village meeting and handout' (OR = 6.0); and 'village meeting' (OR = 7.3) were the dissemination methods used.

Statistically significant odds ratios were obtained with the method of prevention of mastitis **'good hygiene of the milker'** when 'village meeting and video' (OR = 10.1); 'handout' (OR = 10.2); 'village meeting, video and handout' (OR = 10.3), and 'village meeting and handout' (OR = 9.3) were the dissemination methods used.

Statistically significant odds ratios were obtained with the method of prevention of mastitis **'isolation of affected animal'** when 'village meeting and video' (OR = 11.1); 'handout' (OR = 22.0); 'village meeting, video and handout' (OR = 26.7), and 'village meeting and handout' (OR = 15.0) were the dissemination methods used.

Statistically significant odds ratios were obtained with the method of prevention of mastitis **'use one corner of cloth per quarter'** when 'village meeting and video' (OR = 49.6); 'village meeting, video and handout' (OR = 37.3); and 'village meeting' (OR = 14.6) were the dissemination methods used.

Statistically significant odds ratios were obtained with the method of prevention of mastitis **‘wash hands after milking affected cow’** when ‘handout’ (OR = 9.6); and ‘village meeting, video and handout’ (OR = 9.6) were the dissemination methods used

Statistically significant odds ratios were obtained with the method of prevention of mastitis **‘use clean water’** when ‘village meeting and video’ (OR = 10.3) was the dissemination method used.

Statistically significant odds ratios were obtained with the method of prevention of mastitis **‘milk affected cow last’** when ‘village meeting’ (OR = 4.1) was the dissemination method used.

Statistically significant odds ratios were obtained with the method of prevention of mastitis **‘milk affected quarter last’** when ‘village meeting and video’ (OR = 8.2) was the dissemination method used.

Statistically significant odds ratios which represented a ‘negative effect of dissemination’ were obtained with the method of prevention of mastitis **‘use complete milking technique’** when ‘village meeting’ (OR = 0.2) was the dissemination method used.

No statistically significant odds ratios were obtained for the methods of prevention of mastitis **‘treatment of affected cow’** or **‘use only milking salve as teat lubricant’** when any of the dissemination methods were used.

Odds ratios were not obtained for the methods of prevention of mastitis **‘isolation of affected animal at bottom of banda slope’, ‘use one cloth per cow’, ‘wash teats only, not whole udder’, ‘use five finger squeezing technique for milking (i.e. not stripping)’**, or **‘milk affected quarter into separate container’** due to a lack of convergence of data during analysis.

There was variation in the effectiveness of dissemination methods in increasing respondents’ knowledge about the ‘prevention of mastitis’. Three of the methods of prevention of mastitis (‘hygiene of banda’, ‘hygiene of udder cloth’, and ‘discard affected milk safely’) showed a significant association with all of the five dissemination methods, and no association with the ‘Hawthorne control’ group. Two of the methods of prevention of mastitis (‘hygiene of milker’, and ‘isolation of affected cow’) showed a significant association with four of the dissemination methods used, with the exception of the ‘village meeting’ method, and no association with the ‘Hawthorne control’ group.

The 'handout' method was the most successful for disseminating the facts, **'good hygiene of the banda'**, **'good hygiene of the milker'** and **'wash hands after milking affected cow'** as methods of prevention of mastitis. 'Village meeting and video' was the most successful method for disseminating the facts **'good hygiene of the milker'**, **'use one corner of cloth per quarter'**, **'use clean water'**, **'use only milking salve as lubricant'**, and **'milk affected quarter last'** as methods of prevention of mastitis. 'Village meeting, video and handout' was the most successful method for disseminating the facts **'good hygiene of the milker'**, **'isolation of affected cow'**, and **'wash hands after milking affected cow'** as methods of prevention of mastitis. 'Village meeting and handout' was the most successful method for disseminating the fact **'good hygiene of the udder cloth'** as a method of prevention of mastitis. 'Village meeting' was the most successful method for disseminating the fact **'discard affected milk safely'** as a method of prevention of mastitis.

Overall, the 'village meeting and video' method was the most successful in disseminating facts concerning the prevention of mastitis.

Appendix 18 also illustrates the odds ratios, associated confidence intervals and p values for the above findings.

Prevention of Mastitis - 1

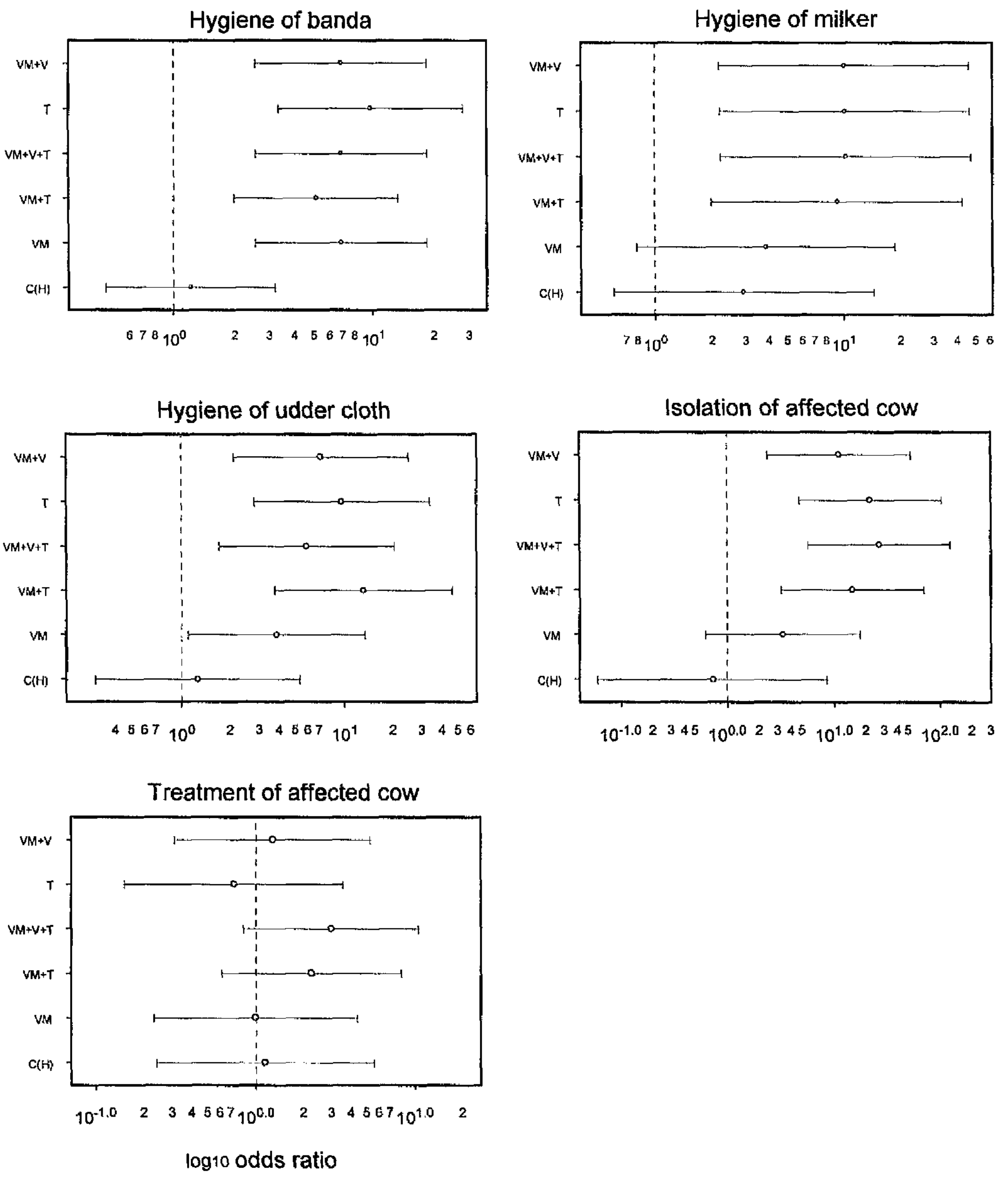


Figure 5-35: Horizontal error bar plots generated in S-plus, illustrating odds ratios (represented by circles) plus their associated confidence intervals (represented by horizontal error bars) for the dissemination of facts concerning the 'prevention of mastitis' by the different dissemination methods (VM+V = village meeting and video; T = text; VM+V+T = village meeting, video and text; VM+T = village meeting and text; VM = village meeting; C(H) = 'Hawthorne' control method) with reference to the control group. A vertical reference line is plotted at point '$\log_{10}0$' (equivalent to the point '1' on a linear scale) which, if crossed by the associated confidence intervals, illustrates that the odds ratio is not statistically significant. 'Text' refers to the project handout.

Prevention of Mastitis - 2

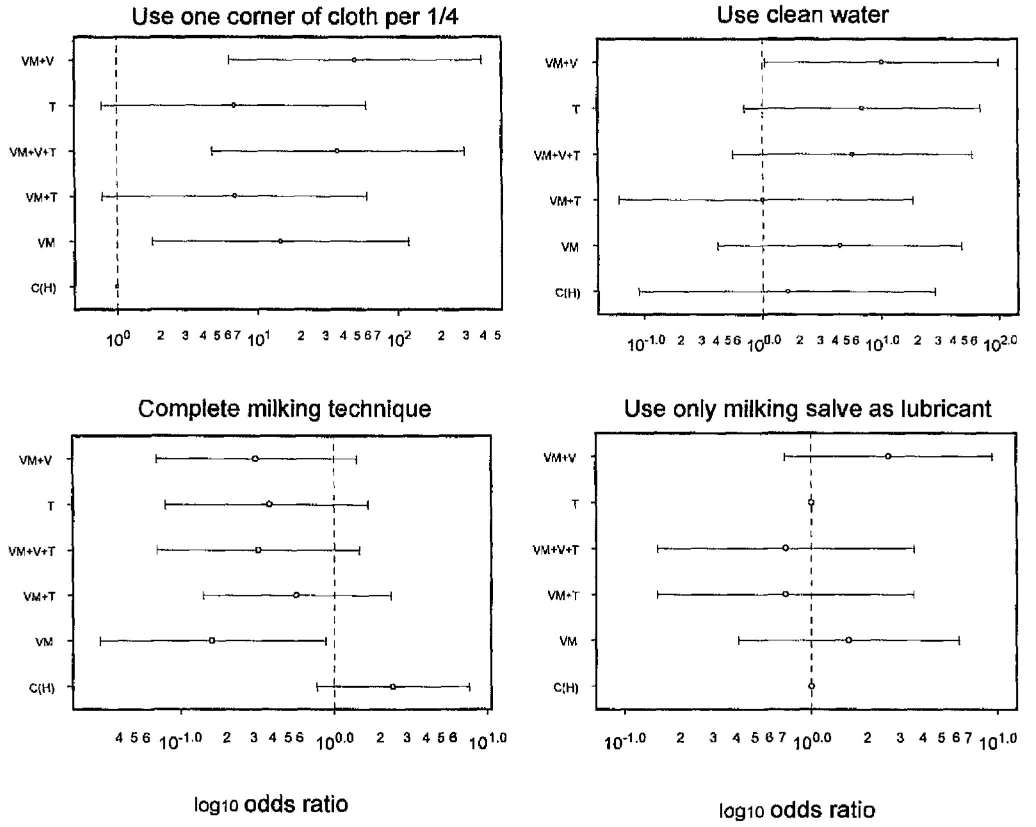


Figure 5-36: Horizontal error bar plots generated in S-plus, illustrating odds ratios (represented by circles) plus their associated confidence intervals (represented by horizontal error bars) for the dissemination of facts concerning the 'prevention of mastitis' by the different dissemination methods (VM+V = village meeting and video; T = text; VM+V+T = village meeting, video and text; VM+T = village meeting and text; VM = village meeting; C(H) = 'Hawthorne' control method) with reference to the control group. A vertical reference line is plotted at point '$\log_{10}0$' (equivalent to the point '1' on a linear scale) which, if crossed by the associated confidence intervals, illustrates that the odds ratio is not statistically significant. 'Text' refers to the project handout.

Prevention of Mastitis - 3

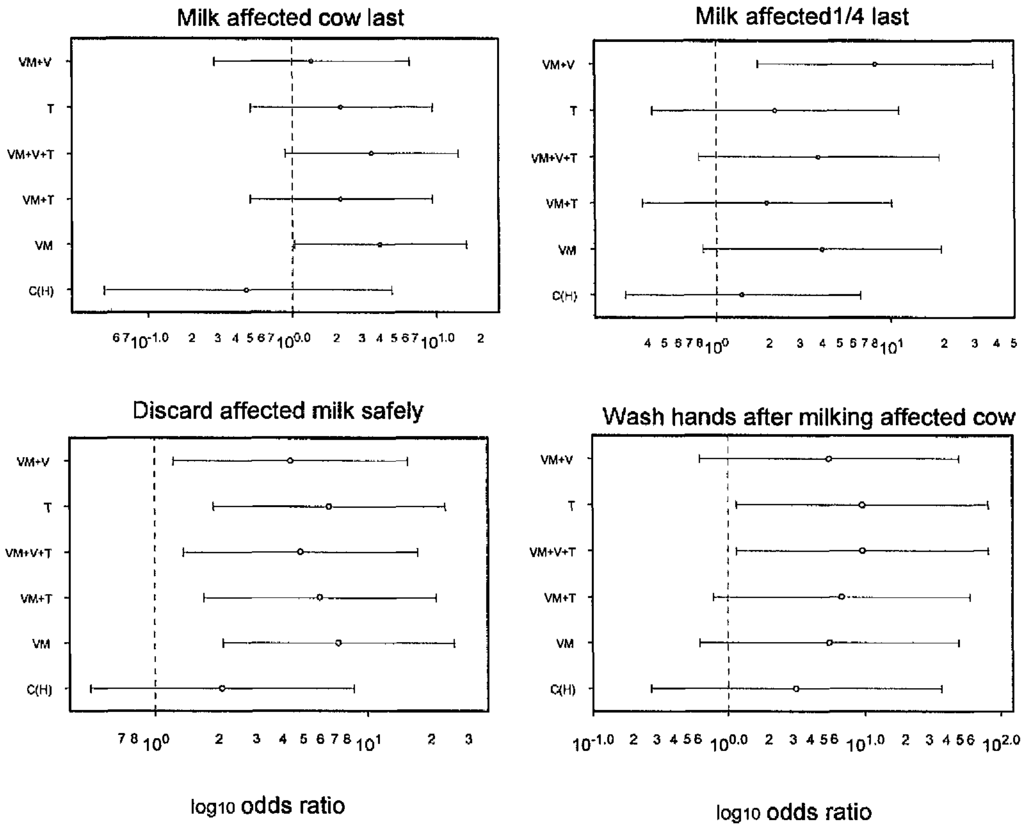


Figure 5-37: Horizontal error bar plots generated in S-plus, illustrating odds ratios (represented by circles) plus their associated confidence intervals (represented by horizontal error bars) for the dissemination of facts concerning the 'prevention of mastitis' by the different dissemination methods (VM+V = village meeting and video; T = text; VM+V+T = village meeting, video and text; VM+T = village meeting and text; VM = village meeting; C(H) = 'Hawthorne' control method) with reference to the control group. A vertical reference line is plotted at point '$log_{10}0$' (equivalent to the point '1' on a linear scale) which, if crossed by the associated confidence intervals, illustrates that the odds ratio is not statistically significant. 'Text' refers to the project handout.

5.4.4.2 Multilevel modelling for 'overall mastitis knowledge of respondents'

Analysis was carried out to investigate variables associated with respondents' mastitis knowledge, as defined by 'volunteering mastitis facts post-dissemination'. Two different multilevel models were used, the first assessed the contribution of individual question, farm, and village (Model 1) to the overall variation, whilst the second assessed the contribution of individual question, question number and question type (Model 2) to the overall variation. Individual question level (level 1) refers to an individual respondent being asked an individual question, whilst question type refers to the category of question e.g. signs of mastitis. Throughout this section, figures refer to the project handout as 'text'.

5.4.4.2.1 Multilevel Model 1 for 'overall mastitis knowledge', with individual question, farm, and village as random effects

The contribution of each of the three levels, individual question, farm and village, calculated by the latent variable approach and binary linearisation model of estimating Intra-Class Correlation Coefficient (ICC), are shown in Table 5-2. Results show that over 93% of the variation was at the individual question level, with very little variation in knowledge between farms and villages. In the intercept only models there was slightly more variation between villages, than between farms within villages, however a large proportion of the variation at village level, was subsequently accounted for by fixed terms in the final model (Model 1c).

Level	ICC (%) (latent variable approach)	ICC (%) (binary linearisation model)	ICC (%) (latent variable approach)
	Intercept only	*Intercept only*	*Including fixed effects* (Model 1c)
Village	5.2	3.3	0.5
Farm	1.1	0.9	1.6
Individual question	93.7	95.8	97.9

Table 5-2: ICC for model 1 calculated by the latent variable approach and the binary linearisation model. These models considered three levels of random effect, namely village, farm and individual question.

Univariable analysis

Univariable analysis for the outcome variable 'volunteering mastitis facts post-dissemination', using the 2nd order PQL method of estimation revealed a number of significant explanatory variables with a critical probability of 0.05. Variables that were significantly associated with 'volunteering mastitis facts post-dissemination' during univariable analysis are illustrated in Tables 5-3, 5-4, and 5-5. Two univariable models (1a and 1b) were used to evaluate the effectiveness of the different dissemination methods, with the first model (1a) using the 'control' group, and the second model (1b) using the 'village meeting' group as reference categories. 'Village meeting' was selected as the reference category for model 1b, owing to the fact that it was the dissemination method with the lowest odds ratio in model 1a. Further variables found to be significant during univariable analysis are discussed after Model 1b.

Model 1a

Model 1a (Fig 5-38 and Table 5-3), with 'control' group as the reference category, showed that all of the five dissemination methods demonstrated significant odds ratios greater than 2.2, suggesting that they were all effective at disseminating mastitis knowledge compared to the 'control' group. Respondents exposed to these methods were at least twice as likely as those in the 'control' group to volunteer mastitis facts post-dissemination. The odds ratios for each of the dissemination methods 'village meeting and video', 'village meeting and handout', 'handout' and 'village meeting, video and handout' were similar, ranging from 2.82 to 3.10. The 'Hawthorne control' group showed a non-significant odds ratio of 1.02, suggesting that this method showed no significant difference from the control group in disseminating knowledge about mastitis, which suggests that administration of the pre-dissemination questionnaire therefore had no significant effect on a respondent's subsequent mastitis knowledge.

$$\left.\begin{array}{l} \text{outcomepost}_{indqu,farm,village} \sim \text{Binomial}(\text{denom}_{indqu,farm,village}, \pi_{indqu,farm,village}) \\ \text{outcomepost}_{indqu,farm,village} = \pi_{indqu,farm,village} + e_{0indqu,farm,village}\text{cons}^{*} \end{array}\right\}$$

$$\begin{aligned} \text{logit}(\pi_{indqu,farm,village}) = {} & \beta_{1farm,village}\text{bcons} + 1.076(0.124)\text{methodvmeetingandvideo}_{village} + \\ & 1.037(0.124)\text{methodvmeetingandtext}_{village} + 1.092(0.124)\text{methodtext}_{village} + \\ & 0.828(0.125)\text{methodvmeeting}_{village} + \\ & 1.132(0.124)\text{methodvmeetingvideoandtext}_{village} + \\ & 0.022(0.106)\text{methodhawthorne}_{farm,village} \end{aligned}$$

$$\beta_{1farm,village} = -1.629(0.092) + v_{1village} + u_{1farm,village}$$

$$\left[v_{1village}\right] \sim \text{N}(0,\ \Omega_v)\ :\ \Omega_v = \left[0.025(0.010)\right]$$

$$\left[u_{1farm,village}\right] \sim \text{N}(0,\ \Omega_u)\ :\ \Omega_u = \left[0.040(0.012)\right]$$

$$\text{cons}^{*} = \text{cons}[\pi_{indqu,farm,village}(1 - \pi_{indqu,farm,village})/\text{denom}_{indqu,farm,village}]^{0.5}$$

$$\left[e_{0indqu,farm,village}\right] \sim (0,\ \Omega_e)\ :\ \Omega_e = \left[1.000(0.000)\right]$$

Figure 5-38: Multilevel Model 1a for dissemination methods associated with mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination'. The reference category in this model is the 'control' group of dissemination. 'Text' refers to the project handout.

Regression terms	*Estimates*	*SE*	*OR*	*95% CI OR*	*p value*
Random effects	*Variance*				
Village	0.025	0.01			
Farm	0.04	0.012			
Individual question	1	0			
Fixed effects	*Coefficients*				
Dissemination method					
-Control*			1.00		
-Village meeting and video	1.076	0.124	2.93	2.59,3.32	<0.0001
-Village meeting and handout	1.037	0.124	2.82	2.49,3.19	<0.0001
-Handout	1.092	0.124	2.98	2.63,3.37	<0.0001
-Village meeting	0.828	0.125	2.29	2.02,2.59	<0.0001
-Village meeting, video and handout	1.132	0.124	3.10	2.74,3.51	<0.0001
-Hawthorne control	0.022	0.106	1.02	0.92,1.14	0.8356

Table 5-3: Multilevel Model 1a for dissemination methods associated with mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination'. The reference category for this model is the 'control' group, marked by * in the table.

Model 1b

Model 1b (Figure 5-39 and Table 5-4) showed that the dissemination methods 'village meeting and video', 'handout' and 'village meeting, video and handout', with odds ratios greater than 1.28 were more effective at knowledge dissemination than the 'village meeting' method of dissemination. 'Village meeting and handout' had an odds ratio of 1.23, however this was not statistically significant. Therefore, in addition to being effective compared to the 'control' group, this model demonstrated that the dissemination methods 'village meeting and video', 'handout' and 'village meeting, video and handout' were also more effective than the 'village meeting' method in their ability to disseminate mastitis knowledge.

A further model (not shown), in which all dissemination methods were then compared to the reference category of 'village meeting and handout', showed that the dissemination methods 'village meeting and video', 'handout' and 'village meeting, video and handout' were not more effective compared to the 'village meeting and handout' method in their ability to disseminate mastitis knowledge.

$$\left.\begin{array}{l} \text{outcomepost}_{indqu,farm,village} \sim \text{Binomial}(\text{denom}_{indqu,farm,village}, \pi_{indqu,farm,village}) \\ \text{outcomepost}_{indqu,farm,village} = \pi_{indqu,farm,village} + e_{0indqu,farm,village}\text{cons}^{*} \end{array}\right\}$$

$$\begin{aligned} \text{logit}(\pi_{indqu,farm,village}) = {} & \beta_{1farm,village}\text{bcons} + -0.828(0.125)\text{methodcontrol}_{farm,village} + \\ & 0.248(0.120)\text{methodvmeetingandvideo}_{village} + \\ & 0.209(0.120)\text{methodvmeetingandtext}_{village} + 0.263(0.120)\text{methodtext}_{village} + \\ & 0.304(0.120)\text{methodvmeetingvideoandtext}_{village} + \\ & -0.806(0.136)\text{methodhawthorne}_{farm,village} \end{aligned}$$

$$\beta_{1farm,village} = -0.801(0.085) + v_{1village} + u_{1farm,village}$$

$$\begin{bmatrix} v_{1village} \end{bmatrix} \sim \text{N}(0, \Omega_v) : \Omega_v = \begin{bmatrix} 0.025(0.010) \end{bmatrix}$$

$$\begin{bmatrix} u_{1farm,village} \end{bmatrix} \sim \text{N}(0, \Omega_u) : \Omega_u = \begin{bmatrix} 0.040(0.012) \end{bmatrix}$$

$$\text{cons}^{*} = \text{cons}[\pi_{indqu,farm,village}(1 - \pi_{indqu,farm,village})/\text{denom}_{indqu,farm,village}]^{0.5}$$

$$\begin{bmatrix} e_{0indqu,farm,village} \end{bmatrix} \sim (0, \Omega_e) : \Omega_e = \begin{bmatrix} 1.000(0.000) \end{bmatrix}$$

Figure 5-39: Multilevel Model 1b for dissemination methods associated with mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination'. The reference category in this model is the 'village meeting' group of dissemination. 'Text' refers to the project handout.

Regression terms	*Estimates*	*SE*	*OR*	*95% CI OR*	*p value*
Random effects	*Variance*				
Village	0.025	0.01			
Farm	0.04	0.012			
Individual question	1	0			
Fixed effects	*Coefficients*				
Dissemination method					
-Control	-0.828	0.125	0.44	0.39,0.50	<0.0001
-Village meeting and video	0.248	0.120	1.28	1.14,1.44	0.0388
-Village meeting and handout	0.209	0.120	1.23	1.09,1.39	0.0816
-Handout	0.263	0.120	1.30	1.15,1.47	0.0284
-Village meeting*			1.00		
-Village meeting, video and handout	0.304	0.120	1.36	1.20,1.53	0.0113
-Hawthorne control	-0.806	0.136	0.45	0.39,0.51	<0.0001

Table 5-4: Multilevel Model 1b for dissemination methods associated with mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination'. The reference category for this model is the 'village meeting' method, marked by * in the table.

Other variables with significant association during univariable analysis (Table 5-5) included the respondent volunteering post-dissemination, in response to the question "How did you learn about mastitis?" that they had learned from either a Buhuri training course, project (DFID) training, another training course, or a pamphlet. The odds ratios for these volunteered methods of learning ranged from 1.14 to 1.47 and were therefore much lower than those obtained for the dissemination methods used by this study.

There was also significant association with the categories of question type, 'identification', 'action taken', 'signs', 'effects' and 'spread', when compared to the 'prevention' category, with odds ratios ranging from 1.61 to 4.37. This suggests that respondents were able to answer certain question types better than others

Positive associations with volunteering mastitis facts post-dissemination were also seen with respondents who had received higher education, when compared to standard level education, and also with the age of the respondent.

A positive association with volunteering mastitis facts post-dissemination was also seen with the pre-dissemination proportion of respondents who were able to volunteer the specific mastitis fact, which gave an indication of the background level of knowledge about a fact prior to dissemination.

Variables which were found to be non-significant during univariable analysis included the gender of the respondent; the role of the respondent within the household; illiteracy of the respondent; experience of a mastitis case in the respondent's cow; the number of cattle owned; concurrent ownership of local cattle; sourcing the dairy cow privately or through a HIT or TWIT credit; repayment of a HIT or TWIT credit; and rural, peri-urban or urban location (data not shown). Such variables were, therefore, excluded from further analysis.

Fixed effect	*ß*	*95% CI ß*	*OR*	*95% CI OR*	*p value*
Question type					
-Prevention*			1.00		
-Identification			1.61	1.51,1.72	<0.0001
-Action taken			4.37	3.97,4.80	<0.0001
-Signs			4.06	3.85,4.28	<0.0001
-Effects			2.81	2.66,2.98	<0.0001
-Spread			2.42	2.29,2.56	<0.0001
Age	0.004	0.000,0.008			0.0455
Methods of learning about mastitis volunteered (post)					
-Learned from nowhere *			1.00		
-Learned from Buhuri			1.14	1.08,1.21	0.0124
-Learned from EO			1.06	0.99,1.14	0.3619
-Learned from DFID training			1.16	1.09,1.23	0.0130
-Learned from other training course			1.39	1.26,1.54	0.0011
-Learned from other farmer			1.03	0.90,1.17	0.8307
-Learned from mastitis case			1.07	0.98,1.17	0.4382
-Learned from pamphlet			1.47	1.29,1.68	0.0031
Education level					
-None			0.95	0.83,1.08	0.6859
-Standard (primary)*			1.00		
-Form (secondary)			1.07	1.01,1.13	0.2329
-Higher			1.32	1.25,1.40	<0.0001
% of respondents answering same question correctly (pre)	0.042	0.040,0.044			<0.0001

Table 5-5: Further significant explanatory variables for Model 1 for the outcome variable 'volunteering mastitis facts post-dissemination' following univariable analysis, with fixed effects of individual question, farm and village. The reference category of a group of dummy variables is marked by * in the table.

Multivariable analysis

Three different models were used to estimate the contribution of explanatory variables to the outcome variable defined as ‘volunteering mastitis facts post-dissemination’. The third model (1c) combined the dissemination methods in Model 1a with further explanatory variables, in order to provide a final multilevel model (Model 1c) to describe the outcome variable, with the random effects of village, farm and individual question taken into consideration, and allowing for residual confounding from other variables. Multivariable analysis was done by fitting more than one variable into the model adopting a backwards stepwise elimination procedure. Final estimation of all models was done using a 2nd order PQL estimation method.

Model 1c – Final multilevel model

The final multilevel model (Figure 5-40 and Table 5-6) for mastitis knowledge, defined by ‘volunteering mastitis facts post-dissemination’, with random effects of village, farm and individual question, included positive associations with all of the five dissemination methods, ‘village meeting and video’, ‘village meeting and handout’, ‘handout’, ‘village meeting’ and ‘village meeting, video and handout’ dissemination methods, when compared to the ‘control’ group. This suggests that the five dissemination methods were effective at disseminating mastitis knowledge compared to the control group. Of the five dissemination methods, the ‘handout’ method (OR=3.50) was the most effective, whilst the combination methods ‘village meeting and video’ (OR=3.22), ‘village meeting and handout’ (OR=3.28) and ‘village meeting, video and handout’ (OR=3.34) methods all showed very similar effect, and ‘village meeting’ method (OR=2.61) was the least effective.

A positive association was seen when the respondent volunteered post-dissemination, in response to the question “How did you learn about mastitis?”, that they had learned from a Buhuri training course, DFID training, another training course or a pamphlet. The odds ratios for these volunteered methods of learning about mastitis ranged from 1.17 to 1.57 and were, therefore much lower than those seen for the five dissemination methods used in the study.

There were also positive associations with respondents who had received ‘form’ or ‘higher’ level education, compared to ‘standard’ level; and with the percentage of respondents able to volunteer the specific mastitis fact pre-dissemination.

There was also a positive association with the 'signs', 'effects' and 'spread' categories of question, when compared to the 'prevention' category, however a negative association was seen with the 'identification' category of question, when compared to the 'prevention' category (Table 5-6).

$$
\left.\begin{aligned}
&\mathbf{outcomepost}_{indqu,farm,village} \sim \text{Binomial}(\mathbf{denom}_{indqu,farm,village}, \pi_{indqu,farm,village})\\
&\mathbf{outcomepost}_{indqu,farm,village} = \pi_{indqu,farm,village} + e_{0indqu,farm,village}\mathbf{cons}^{*}
\end{aligned}\right\}
$$

$$
\begin{aligned}
\text{logit}(\pi_{indqu,farm,village}) = {} & \beta_{1farm,village}\mathbf{bcons} + 1.169(0.124)\mathbf{methodvmeetingandvideo}_{village} + \\
& 1.187(0.123)\mathbf{methodvmeetingandtext}_{village} + 1.253(0.122)\mathbf{methodtext}_{village} + \\
& 0.959(0.123)\mathbf{methodvmeeting}_{village} + \\
& 1.205(0.125)\mathbf{methodvmeetingvideoandtext}_{village} + \\
& 0.021(0.119)\mathbf{methodhawthorne}_{farm,village} + \\
& 0.160(0.060)\mathbf{learnedbuhuripost}_{farm,village} + \\
& 0.001(0.077)\mathbf{learnedeopost}_{farm,village} + 0.171(0.067)\mathbf{learneddfidpost}_{farm,village} + \\
& 0.269(0.118)\mathbf{learnedothertrainingpost}_{farm,village} + \\
& -0.004(0.148)\mathbf{learnedotherfarmerpost}_{farm,village} + \\
& 0.082(0.102)\mathbf{learnedcasepost}_{farm,village} + \\
& 0.448(0.144)\mathbf{learnedpamphletpost}_{farm,village} + -0.085(0.153)\mathbf{none}_{farm,village} + \\
& 0.136(0.062)\mathbf{form}_{farm,village} + 0.350(0.069)\mathbf{higher}_{farm,village} + \\
& -0.275(0.076)\mathbf{identification}_{indqu,farm,village} + \\
& 0.033(0.126)\mathbf{actiontaken}_{indqu,farm,village} + 0.675(0.060)\mathbf{signs}_{indqu,farm,village} + \\
& 0.884(0.059)\mathbf{effects}_{indqu,farm,village} + 0.884(0.056)\mathbf{spread}_{indqu,farm,village} + \\
& 0.043(0.001)\mathbf{percentpre}_{indqu,farm,village}
\end{aligned}
$$

$$\beta_{1farm,village} = -2.946(0.107) + v_{1village} + u_{1farm,village}$$

$$\begin{bmatrix} v_{1village} \end{bmatrix} \sim \text{N}(0,\ \Omega_v) : \Omega_v = \begin{bmatrix} 0.017(0.009) \end{bmatrix}$$

$$\begin{bmatrix} u_{1farm,village} \end{bmatrix} \sim \text{N}(0,\ \Omega_u) : \Omega_u = \begin{bmatrix} 0.054(0.015) \end{bmatrix}$$

$$\mathbf{cons}^{*} = \mathbf{cons}[\pi_{indqu,farm,village}(1 - \pi_{indqu,farm,village})/\mathbf{denom}_{indqu,farm,village}]^{0.5}$$

$$\begin{bmatrix} e_{0indqu,farm,village} \end{bmatrix} \sim (0,\ \Omega_e) : \Omega_e = \begin{bmatrix} 1.000(0.000) \end{bmatrix}$$

Figure 5-40: Final multilevel Model 1c for variables associated with mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination'. Random effects considered in this model are village, farm and individual question. 'Text' refers to the project handout.

Regression terms	*Estimates*	*S.E.*	*β*	*95% CI β*	*OR*	*95% CI OR*	*p value*
Random effects	*Variance*						
Village	0.017	0.009					
Farm	0.054	0.015					
Individual question	1	0					
Fixed effects	*Coefficients*						
Dissemination method							
-Control*					1.00		
-Village meeting and video	1.169	0.124			3.22	2.84,3.64	<0.0001
-Village meeting and handout	1.187	0.123			3.28	2.90,3.71	<0.0001
-Handout	1.253	0.122			3.50	3.10,3.96	<0.0001
-Village meeting	0.959	0.123			2.61	2.31,2.95	<0.0001
-Village meeting, video and handout	1.205	0.125			3.34	2.94,3.78	<0.0001
-Hawthorne control	0.021	0.119			1.02	0.91,1.15	0.8599
Methods of learning about mastitis volunteered							
-Learned from nowhere (post)*					1.00		
-Learned from Buhuri (post)	0.16	0.06			1.17	1.11-1.25	0.0077
-Learned from EO (post)	0.001	0.077			1.00	0.93-1.08	0.9896
-Learned from DFID training (post)	0.171	0.067			1.19	1.11-1.27	0.0107
-Learned from other training course (post)	0.269	0.118			1.31	1.16-1.47	0.0226
-Learned from other farmer (post)	-0.004	0.148			1.00	0.86-1.15	0.9784
-Learned from mastitis case (post)	0.082	0.102			1.09	0.98,1.20	0.4214
-Learned from pamphlet (post)	0.448	0.144			1.57	1.36,1.81	0.0019
Level of education							
-None	-0.085	0.153			0.92	0.79,1.07	0.5785
-Standard (primary)*					1.00		
-Form (secondary)	0.136	0.062			1.15	1.08,1.22	0.0283
-Higher	0.35	0.069			1.42	1.32,1.52	<0.0001
Question type							
-Identification	-0.275	0.076			0.76	0.70,0.82	0.0003
-Action taken	0.033	0.126			1.03	0.91,1.17	0.7934
-Signs	0.675	0.06			1.96	1.85,2.09	<0.0001
-Effects	0.884	0.059			2.42	2.28,2.57	<0.0001
-Spread	0.884	0.056			2.42	2.29,2.56	<0.0001
-Prevention*					1.00		
% of respondents answering same question correctly (pre)	0.043	0.001	0.043	0.041,0.045			<0.0001

Table 5-6: Final multilevel Model 1c for explanatory variables associated with mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination'. Random effects considered in this model are village, farm and individual question. Where applicable, an entire group of associated dummy variables are shown, with the reference category marked by * in the table.

5.4.4.2.2 Multilevel Model 2 for 'overall mastitis knowledge' with individual question, question number, and question type as random effects

The contribution of each of the levels, individual question, question number, and question type by the latent variable approach and binary linearisation model of estimating ICC is shown in Table 5-7. The ICC at the level of question type was less than 7%, however there was a large degree of variation at both the individual question level (over 59%), and at the question number level (over 20%), reflecting the considerable variation in responses to individual questions. On comparison of the ICCs obtained by the latent variable approach, a proportion of the variation at question number level, was subsequently accounted for by fixed terms in the final model (Model 2c), as shown in Table 5-7.

Level	ICC (%) (latent variable approach)	ICC (%) (binary linearisation model)	ICC (%) (latent variable approach)
	Intercept only	*Intercept only*	*Including fixed terms* (Model 2c)
Question type	6.7	4.2	4.8
Question number	34.2	20.4	27.5
Individual question	59.1	75.5	67.8

Table 5-7: ICC for model 2, as calculated by the latent variable approach and the binary linearisation model. These models considered three levels of random effect, namely question type, question number, and individual question.

Univariable analysis

Univariable analysis for the outcome variable 'volunteering mastitis facts post-dissemination', using a 2^{nd} order PQL method of estimation revealed a number of significant explanatory variables with a critical probability of 0.05, as illustrated in Tables 5-8, 5-9 and 5-10.

Following a similar pattern to that used for Models 1a, 1b and 1c, the first two univariable models (2a and 2b) which considered the random effects of question type, question number and individual question, were used to evaluate the effectiveness of the different dissemination methods, with the first model (2a) using the 'control' group, and the second model (2b) using the 'village meeting' group as reference categories. The 'village meeting' group was selected as the reference category for model 2b, owing to the fact that it was the dissemination method with the lowest odds ratio in model 2a. Other variables found to be significant during univariable analysis are discussed following Model 2b.

Model 2a

Model 2a (Fig 5-41 and Table 5-8) showed that all of the five dissemination methods demonstrated significant odds ratios greater than 2.99, suggesting that all methods were effective at disseminating mastitis knowledge compared to the 'control' group, and that respondents exposed to these methods were almost three times as likely as those in the control group to volunteer mastitis facts post-dissemination. The odds ratios for each of the dissemination methods 'village meeting and video' (OR=4.21), 'village meeting and handout' (OR=3.97), 'handout' (OR=4.26) and 'village meeting, video and handout' (OR=4.51) were similar, suggesting that these methods were all of similar efficacy. The 'Hawthorne' control group showed a non-significant odds ratio of 1.08, suggesting that administration of the pre-dissemination questionnaire had no significant effect on respondent's subsequent mastitis knowledge. Variance at the level of question type was shown to be extremely small, as represented by the variance estimate and standard error term in Fig 5-8.

$$\left.\begin{array}{l}\text{outcomepost}_{indqu,\,quno,\,qutype} \sim \text{Binomial}(\text{denom}_{indqu,\,quno,\,qutype},\, \pi_{indqu,\,quno,\,qutype}) \\ \text{outcomepost}_{indqu,\,quno,\,qutype} = \pi_{indqu,\,quno,\,qutype} + e_{0indqu,\,quno,\,qutype}\text{cons}^{*}\end{array}\right\}$$

$$\begin{aligned}\text{logit}(\pi_{indqu,\,quno,\,qutype}) = {} & \beta_{1quno,\,qutype}\text{bcons} + 1.437(0.090)\text{methodvmeetingandvideo}_{indqu,\,quno,\,qutype} + \\ & 1.379(0.089)\text{methodvmeetingandtext}_{indqu,\,quno,\,qutype} + \\ & 1.450(0.090)\text{methodtext}_{indqu,\,quno,\,qutype} + \\ & 1.096(0.088)\text{methodvmeeting}_{indqu,\,quno,\,qutype} + \\ & 1.507(0.090)\text{methodvmeetingvideoandtext}_{indqu,\,quno,\,qutype} + \\ & 0.073(0.101)\text{methodhawthorne}_{indqu,\,quno,\,qutype}\end{aligned}$$

$$\beta_{1quno,\,qutype} = -2.018(0.351) + v_{1qutype} + u_{1quno,\,qutype}$$

$$\left[v_{1qutype}\right] \sim \text{N}(0,\ \Omega_v)\ :\ \Omega_v = \left[0.413(0.396)\right]$$

$$\left[u_{1quno,\,qutype}\right] \sim \text{N}(0,\ \Omega_u)\ :\ \Omega_u = \left[2.037(0.426)\right]$$

$$\text{cons}^{*} = \text{cons}[\pi_{indqu,\,quno,\,qutype}(1 - \pi_{indqu,\,quno,\,qutype})/\text{denom}_{indqu,\,quno,\,qutype}]^{0.5}$$

$$\left[e_{0indqu,\,quno,\,qutype}\right] \sim (0,\ \Omega_e)\ :\ \Omega_e = \left[1.000(0.000)\right]$$

Figure 5-41: Multilevel Model 2a for dissemination methods associated with mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination'. The reference category in this model is the 'control' group of dissemination. 'Text' refers to the project handout.

Regression terms	*Estimates*	*S.E.*	*OR*	*95% CI OR*	*p value*
Random effects	*Variance*				
Question type	0.413	0.396			
Question number	2.037	0.426			
Individual question	1	0			
Fixed effects	*Coefficients*				
Dissemination method					
-Control*			1.00		
-Village meeting and video	1.437	0.090	4.21	3.85,4.60	<0.0001
-Village meeting and handout	1.379	0.089	3.97	3.63,4.34	<0.0001
-Handout	1.450	0.090	4.26	3.90,4.66	<0.0001
-Village meeting	1.096	0.088	2.99	2.74,3.27	<0.0001
-Village meeting, video and handout	1.507	0.090	4.51	4.12,4.94	<0.0001
-Hawthorne control	0.073	0.101	1.08	0.97,1.19	0.4698

Table 5-8: Multilevel Model 2a for dissemination methods associated with mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination'. The reference category for this model is the 'control' group of dissemination, marked by * in the table.

Model 2b

Model 2b (Fig 5-42 and Table 5-9) showed that the dissemination methods 'village meeting and video', 'village meeting and handout', 'handout' and 'village meeting, video and handout', with odds ratios greater than 1.33, were more effective at mastitis knowledge dissemination than the 'village meeting' method of dissemination. This model demonstrated that, in addition to being effective compared to the control group, these dissemination methods were significantly better than the 'village meeting' method, and the dissemination methods used were also significantly different from each other in their ability to disseminate mastitis knowledge.

A further model (not shown), in which all dissemination methods were compared to the reference category of 'village meeting and handout', showed that the dissemination methods 'village meeting and video', 'handout' and 'village meeting, video and handout' were not significantly better than the 'village meeting and handout' method in their ability to disseminate mastitis knowledge.

$$\left.\begin{array}{l}\mathbf{outcomepost}_{indqu,\,quno,\,qutype} \sim \mathbf{Binomial}(\mathbf{denom}_{indqu,\,quno,\,qutype},\ \pi_{indqu,\,quno,\,qutype}) \\ \mathbf{outcomepost}_{indqu,\,quno,\,qutype} = \pi_{indqu,\,quno,\,qutype} + e_{0indqu,\,quno,\,qutype}\mathbf{cons}^{*}\end{array}\right\}$$

$$\begin{aligned}\mathrm{logit}(\pi_{indqu,\,quno,\,qutype}) = {}& \beta_{1quno,\,qutype}\mathbf{bcons} + -1.096(0.088)\mathbf{methodcontrol}_{indqu,\,quno,\,qutype} + \\ & 0.341(0.074)\mathbf{methodvmeetingandvideo}_{indqu,\,quno,\,qutype} + \\ & 0.283(0.074)\mathbf{methodvmeetingandtext}_{indqu,\,quno,\,qutype} + 0.354(0.074)\mathbf{methodtext}_{indqu,\,quno,\,qutype} + \\ & 0.411(0.074)\mathbf{methodvmeetingvideoandtext}_{indqu,\,quno,\,qutype} + \\ & -1.023(0.097)\mathbf{methodhawthorne}_{indqu,\,quno,\,qutype}\end{aligned}$$

$$\beta_{1quno,\,qutype} = -0.922(0.347) + v_{1qutype} + u_{1quno,\,qutype}$$

$$\left[v_{1qutype}\right] \sim \mathrm{N}(0,\ \Omega_v) \ :\ \Omega_v = \left[0.413(0.396)\right]$$

$$\left[u_{1quno,\,qutype}\right] \sim \mathrm{N}(0,\ \Omega_u) \ :\ \Omega_u = \left[2.037(0.426)\right]$$

$$\mathbf{cons}^{*} = \mathbf{cons}[\pi_{indqu,\,quno,\,qutype}(1 - \pi_{indqu,\,quno,\,qutype})/\mathbf{denom}_{indqu,\,quno,\,qutype}]^{0.5}$$

$$\left[e_{0indqu,\,quno,\,qutype}\right] \sim (0,\ \Omega_e) \ :\ \Omega_e = \left[1.000(0.000)\right]$$

Figure 5-42: Multilevel Model 2b for dissemination methods associated with mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination'. The reference category in this model is the 'village meeting' group of dissemination. 'Text' refers to the project handout.

Regression terms	*Estimates*	*S.E.*	*OR*	*95% CI OR*	*p value*
Random effects	*Variance*				
Question type	0.413	0.396			
Question number	2.037	0.426			
Individual question	1	0			
Fixed effects	*Coefficients*				
Dissemination method					
-Control	-1.096	0.088	0.33	0.31,0.36	<0.0001
-Village meeting and video	0.341	0.074	1.41	1.31,1.51	<0.0001
-Village meeting and handout	0.283	0.074	1.33	1.23,1.43	0.0001
-Handout	0.354	0.074	1.42	1.32,1.53	<0.0001
-Village meeting*			1.00		
-Village meeting, video and handout	0.411	0.074	1.51	1.40,1.62	<0.0001
-Hawthorne control	-1.023	0.097	0.36	0.33,0.40	<0.0001

Table 5-9: Multilevel Model 2b for dissemination methods associated with mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination'. The reference category for this model is the 'village meeting' group of dissemination, marked by * in the table.

Other variables with significant association following univariable analysis included the respondent volunteering that they had heard of mastitis post-dissemination, and the respondent volunteering post-dissemination that they had learned about mastitis from Buhuri, from their EO, from the project (DFID) training, another training course, a mastitis clinical case or a pamphlet. The odds ratios for these volunteered methods of learning about mastitis ranged from 1.17 to 2.28 and were, therefore lower than those seen for the five dissemination methods used in the study (Table 5-10).

There was also a small negative association with respondents from a rural village, when compared to an urban area, but a positive association with the age of the respondent, and the respondent being male. There was also a positive association with the respondent having received 'form' or 'higher' level education, when compared to 'standard' level education; having owned a dairy cow for between one and two years, or two and five years, when compared to having owned a dairy cow for more than 5 years. In addition, there was a positive association with the respondent being responsible for milking occasionally; and the percentage of respondents volunteering that particular mastitis fact pre-dissemination. Negative associations were seen when the respondent was a wife of the householder, when compared to being the husband of the household, and when the HIT or TWIT credit had been repaid (Table 5-10).

Variables which were found to be non-significant during univariable analysis included illiteracy of the respondent; experience of a mastitis case in the respondent's cow; the number of cattle owned; concurrent ownership of local cattle; and sourcing the dairy cow privately or through a HIT or TWIT credit. Such variables were therefore excluded from further analysis (data not shown).

Fixed effects	ß	95% CI ß	OR	95% CI OR	p value
Heard of mastitis (post)			3.26	2.41,4.41	0.0001
Methods of learning about mastitis volunteered by respondent (post)					
-Learned from nowhere *			1.00		
-Learned from Buhuri			1.17	1.12,1.23	0.0007
-Learned from EO			1.14	1.07,1.21	0.0422
-Learned from project (DFID) training			1.88	1.78,1.98	<0.0001
-Learned from another training course			1.22	1.11,1.34	0.0352
-Learned from another farmer			1.19	1.06,1.35	0.1468
-Learned from a mastitis case			1.29	1.19,1.40	0.0025
-Learned from pamphlet			2.28	2.03,2.57	<0.0001
Village type					
-Urban*			1.00		
-Rural			0.82	0.78,0.86	0.0001
-Peri-urban			0.92	0.88,0.97	0.1069
Gender					
-Male			1.15	1.11,1.20	0.0004
-Female*			1.00		
Level of education					
-None			1.09	0.96,124	0.4849
-Standard (primary)*			1.00		
-Form (secondary)			1.18	1.12,1.24	0.0008
-Higher			1.77	1.67,1.87	<0.0001
Years owning dairy cattle					
-0to1years			1.12	1.03	0.1586
-1to2years			0.78	0.73	0.0005
-2to5years			1.30	1.24	<0.0001
-More than 5 years*			1.00		
Repaid loan			0.85	0.81,0.89	0.0012
Respondent milks occasionally			1.20	1.14,1.26	0.0002
Age	0.006	0.002,0.010			0.0027
Role in Household					
-Husband*			1.00		
-Wife			0.86	0.82,0.90	0.0006
-Son			0.99	0.91,1.08	0.9259
-Daughter			0.92	0.83,1.03	0.4862
-Relative			0.70	0.54,0.90	0.1548
-Other			1.07	0.76,1.49	0.8517
% of respondents answering same question correctly (pre)	0.047	0.029,0.065			<0.0001

Table 5-10: Further results of univariable analysis for Model 2 for the outcome variable 'volunteering mastitis facts post-dissemination' for three levels of fixed effects, individual question, question number, and question type. Where applicable, an entire group of associated dummy variables are shown, with the reference category marked by *.

Multivariable analysis

Further explanatory variables were then added to Model 2a, in order to provide a final multilevel model (Model 2c) to describe the outcome variable, 'volunteering mastitis facts post-dissemination', with the random effects of question type, question number and individual question taken into consideration (Fig 5-43 and Table 5-11). Multivariable analysis was done by fitting variables into the model adopting a backwards stepwise elimination procedure. Final estimation of all models was done using a 2^{nd} order PQL estimation method.

Model 2c

The final multilevel model for mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination', with random effects of question type, question number and individual question, included positive associations with all of the five dissemination methods, 'village meeting and video', 'village meeting and handout', 'handout', 'village meeting' and 'village meeting, video and handout' dissemination methods, when compared to the 'control' method. Of the five dissemination methods, the 'handout' method (OR=4.09) was the most effective, whilst the combination methods 'village meeting and video' (OR=3.64), 'village meeting and handout' (OR=3.90) and 'village meeting, video and handout' (OR= 3.93) methods all showed very similar effect, and 'village meeting' method (OR=2.96) was the least effective of the five methods. This suggests that all five dissemination methods were effective at disseminating mastitis knowledge compared to the control group, and that respondents in the dissemination groups were almost three times as likely as those in the control groups to volunteer a correct mastitis fact post-dissemination.

A positive association was also seen when the respondent volunteered post-dissemination that they had heard of mastitis, and that they had learned about the disease from a Buhuri training course, project (DFID) training, another training course or a pamphlet.

Respondents living in rural villages showed a small negative association when compared to those in urban areas.

There were also positive associations with respondents who had received 'form' (secondary) or 'higher' level education, compared to 'standard' (primary) level, and with respondents who had owned their dairy cattle for between 2 and 5 years, compared to those who had owned their cattle for 5 years or more (Table 5-11). There was also a positive association with the percentage of respondents able to volunteer the specific mastitis fact pre-dissemination.

$$
\left.\begin{array}{l}
\mathbf{outcomepost}_{indqu,\,quno,\,qutype} \sim \mathbf{Binomial}(\mathbf{denom}_{indqu,\,quno,\,qutype},\ \pi_{indqu,\,quno,\,qutype}) \\
\mathbf{outcomepost}_{indqu,\,quno,\,qutype} = \pi_{indqu,\,quno,\,qutype} + e_{0indqu,\,quno,\,qutype}\mathbf{cons}^{*}
\end{array}\right\}
$$

$$
\begin{aligned}
\mathbf{logit}(\pi_{indqu,\,quno,\,qutype}) = \beta_{1quno,\,qutype}\mathbf{bcons} &+ 1.292(0.092)\mathbf{methodvmeetingandvideo}_{indqu,\,quno,\,qutype} + \\
&1.361(0.089)\mathbf{methodvmeetingandtext}_{indqu,\,quno,\,qutype} + \\
&1.408(0.090)\mathbf{methodtext}_{indqu,\,quno,\,qutype} + \\
&1.086(0.089)\mathbf{methodvmeeting}_{indqu,\,quno,\,qutype} + \\
&1.369(0.092)\mathbf{methodvmeetingvideoandtext}_{indqu,\,quno,\,qutype} + \\
&0.011(0.105)\mathbf{methodhawthorne}_{indqu,\,quno,\,qutype} + \\
&0.718(0.317)\mathbf{heardmastitispost}_{indqu,\,quno,\,qutype} + \\
&0.206(0.053)\mathbf{learnedbuhuripost}_{indqu,\,quno,\,qutype} + \\
&-0.043(0.066)\mathbf{learnedeopost}_{indqu,\,quno,\,qutype} + \\
&0.198(0.058)\mathbf{learneddfidpost}_{indqu,\,quno,\,qutype} + \\
&0.305(0.103)\mathbf{learnedothertrainingpost}_{indqu,\,quno,\,qutype} + \\
&-0.083(0.126)\mathbf{learnedotherfarmerpost}_{indqu,\,quno,\,qutype} + \\
&0.103(0.089)\mathbf{learnedcasepost}_{indqu,\,quno,\,qutype} + \\
&0.552(0.120)\mathbf{learnedpamphletpost}_{indqu,\,quno,\,qutype} + \\
&-0.168(0.058)\mathbf{rural}_{indqu,\,quno,\,qutype} + -0.094(0.055)\mathbf{periurban}_{indqu,\,quno,\,qutype} + \\
&-0.122(0.132)\mathbf{none}_{indqu,\,quno,\,qutype} + 0.192(0.053)\mathbf{form}_{indqu,\,quno,\,qutype} + \\
&0.408(0.060)\mathbf{higher}_{indqu,\,quno,\,qutype} + 0.116(0.089)\mathbf{n01years}_{indqu,\,quno,\,qutype} + \\
&-0.016(0.077)\mathbf{n12years}_{indqu,\,quno,\,qutype} + 0.164(0.050)\mathbf{n25years}_{indqu,\,quno,\,qutype} + \\
&0.138(0.054)\mathbf{respmilksoccasionally}_{indqu,\,quno,\,qutype} + \\
&0.052(0.010)\mathbf{percentpre}_{quno,\,qutype}
\end{aligned}
$$

$$\beta_{1quno,\,qutype} = -3.722(0.445) + v_{1qutype} + u_{1quno,\,qutype}$$

$$\left[v_{1qutype}\right] \sim \mathrm{N}(0,\ \Omega_v) : \Omega_v = \left[0.232(0.236)\right]$$

$$\left[u_{1quno,\,qutype}\right] \sim \mathrm{N}(0,\ \Omega_u) : \Omega_u = \left[1.331(0.280)\right]$$

$$\mathbf{cons}^{*} = \mathbf{cons}[\pi_{indqu,\,quno,\,qutype}(1 - \pi_{indqu,\,quno,\,qutype})/\mathbf{denom}_{indqu,\,quno,\,qutype}]^{0.5}$$

$$\left[e_{0indqu,\,quno,\,qutype}\right] \sim (0,\ \Omega_e) : \Omega_e = \left[1.000(0.000)\right]$$

Figure 5-43: Final multilevel Model 2c for variables associated with mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination'. Random effects considered in this model are question type, question number and individual question. 'Text' refers to the project handout.

Regression terms	*Estimates*	*S.E.*	*ß*	*95% CI ß*	*OR*	*95% CI OR*	*p value*
Random effects	*Variance*						
Question type	0.232	0.236					
Question number	1.331	0.280					
Individual question	1	0					
Fixed effects	*Coefficients*						
Dissemination method							
-Control*					1.00		
-Village meeting and video	1.292	0.092			3.64	3.32,3.99	<0.0001
-Village meeting and handout	1.361	0.089			3.90	3.57,4.26	<0.0001
-Handout	1.408	0.090			4.09	3.74,4.47	<0.0001
-Village meeting	1.086	0.089			2.96	2.71,3.24	<0.0001
-Village meeting, video and handout	1.369	0.092			3.93	3.59,4.31	<0.0001
-Hawthorne control	0.011	0.105			1.01	0.91,1.12	0.9166
Heard of mastitis (post)	0.718	0.317			2.03	1.48,2.79	0.0255
Methods of learning about mastitis volunteered							
-Learned from nowhere (post)*					1.00		
-Learned from Buhuri (post)	0.206	0.053			1.23	1.17-1.30	0.0001
-Learned from EO (post)	-0.043	0.066			0.96	0.90-1.02	0.5147
-Learned from project (DFID training (post)	0.198	0.058			1.22	1.15-1.29	0.0006
-Learned from other training course (post)	0.305	0.103			1.36	1.22-1.50	0.0031
-Learned from other farmer (post)	-0.083	0.126			0.92	0.81-1.04	0.5101
-Learned from mastitis case (post)	0.103	0.089			1.11	1.01,1.21	0.2471
-Learned from pamphlet (post)	0.552	0.120			1.74	1.54,1.96	<0.0001
Classification of village							
- Rural	-0.168	0.058			0.85	0.80,0.90	0.0038
-Periurban	-0.094	0.055			0.91	0.86,0.96	0.0874
-Urban*					1.00		
Level of education							
-None	-0.122	0.132			0.89	0.78,1.01	0.3554
-Standard (primary)*					1.00		
-Form (secondary)	0.192	0.053			1.21	1.15,1.28	0.0003
-Higher	0.408	0.060			1.50	1.42,1.60	<0.0001
Years owning dairy cattle							
-0to1years	0.116	0.089			1.12	1.03,1,23	0.1924
-1to2years	-0.016	0.077			0.98	0.91,1.06	0.8354
-2to5years	0.164	0.050			1.18	1.12,1.24	0.0010
-More than 5 years*					1.00		
Respondent milks occasionally	0.138	0.054			1.15	1.09,1.22	0.0106
% of respondents answering same question correctly (pre)	0.052	0.01	0.052	0.033,0.072			<0.0001

Table 5-11: Final multilevel Model 2c for explanatory variables associated with mastitis knowledge, defined by 'volunteering mastitis facts post-dissemination'. Random effects considered in this model are question type, question number and individual question. Where applicable, an entire group of associated dummy variables are shown, with the reference category marked by * in the table.

5.4.4.3 Multilevel modelling for 'change in mastitis knowledge'

Multilevel models were also used to examine the relationship between the change in mastitis knowledge of individual respondents, as defined by the 'difference between pre- and post-dissemination scores' (outcome variable), and explanatory variables.

Multilevel Model 3 – 'Change in mastitis knowledge' with farm and village as random effects

Estimations of the Intra-Class Correlation Coefficient (ICC), which represent the contribution of the two levels, farm and village, to the overall variation, are shown in Table 5-12. Results from the intercept only model show that the variation was divided almost equally between the village (51.6%) and farm (48.4%) level.

Level	Intercept only model Variance estimate (ICC %)	Including fixed effects (Model 3c) Variance estimate
Village	23.0 (51.6)	2.0
Farm	21.6 (48.4)	16.8

Table 5-12: ICCs for model 3, which considered two levels of random effect, village and farm.

Fixed terms in the final model (Model 3c) accounted for 91.5% of the variation at village level, and 22.2% of variation at farm level. The fact that the model explains most of the variation at the village level suggests that the model provides a good estimation of explanatory variables associated with the outcome variable 'difference in pre- and post-dissemination scores.

Univariable analysis

Univariable analysis for the outcome variable 'difference between pre- and post-dissemination scores', revealed a number of explanatory variables with a critical probability of <0.25. Variables that were significantly associated with the 'difference between pre- and post-dissemination scores' during univariable analysis are illustrated in Tables 5-13, 5-14 and 5-15.

Two models (3a and 3b) were used to evaluate the effectiveness of the different dissemination methods, with the first model (3a) using the 'control' group, and the second model (3b) using the 'village meeting' group as reference categories. The 'village meeting' group was selected as the reference category for model 3b, owing to the fact that the coefficient for this method in model 3a was obviously lower than that of the other four dissemination methods, all of which had similar coefficients. Further variables that were significant on univariable analysis are discussed after Model 3b.

Model 3a

Model 3a (Fig 5-44 and Table 5-13), with 'control' group as the reference category, showed that all of the five dissemination methods demonstrated highly significant positive associations ($p<0.001$) with the outcome variable, suggesting that they were effective at producing a change in mastitis knowledge when compared to the control group. Results of Model 3a suggest that a respondent in the control group was likely to show a difference of 2.69 points between pre- and post-dissemination scores (intercept term), whilst the difference between pre- and post-dissemination scores of respondents in 'village meeting and video' (12.93+2.69=15.62), 'village meeting and handout' (11.07+2.69=13.76), 'handout' (11.60+2.69=14.29), 'village meeting' (8.50+2.69=11.19), and 'village meeting, video and handout' (11.12+2.69=13.81) groups were likely to be increased by the respective amounts shown.

$$\mathbf{scoredifference}_{farm,\ village} \sim \mathrm{N}(XB,\ \Omega)$$

$$\begin{aligned}\mathbf{scoredifference}_{farm,\ village} = {} & \beta_{0farm,\ village}\mathbf{cons} + 12.929(1.635)\mathbf{methodvmeetingandvideo}_{village} + \\ & 11.071(1.635)\mathbf{methodvmeetingandtext}_{village} + \\ & 11.595(1.635)\mathbf{methodtext}_{village} + 8.500(1.635)\mathbf{methodvmeeting}_{village} + \\ & 11.167(1.635)\mathbf{methodvmeetingvideoandtext}_{village}\end{aligned}$$

$$\beta_{0farm,\ village} = 2.690(1.156) + u_{0village} + e_{0farm,\ village}$$

$$\left[u_{0village}\right] \sim \mathrm{N}(0,\ \Omega_u) \ : \ \Omega_u = \left[4.935(1.907)\right]$$

$$\left[e_{0farm,\ village}\right] \sim \mathrm{N}(0,\ \Omega_e) \ : \ \Omega_e = \left[21.598(2.078)\right]$$

*-2*loglikelihood(IGLS)* = **1517.852(252 of 252 cases in use)**

Figure 5-44: Multilevel Model 3a for dissemination methods associated with the change in mastitis knowledge of an individual, defined by 'the difference in pre- and post-dissemination scores'. The reference category in this model is the 'control' group. 'Text' refers to the project handout.

Regression terms	Estimates	S.E.	P Value
Random effects	*Variance estimate*		
Village	4.935	1.907	
Farm	21.598	2.078	
Fixed effects	*Coefficients*		
Dissemination method			
-Control*			
-Village meeting and video	12.929	1.635	<0.0001
-Village meeting and handout	11.071	1.635	<0.0001
-Handout	11.595	1.635	<0.0001
-Village meeting	8.500	1.635	<0.0001
-Village meeting, video and handout	11.167	1.635	<0.0001

Table 5-13: Multilevel Model 3a for dissemination methods associated with the change in mastitis knowledge of an individual, defined by 'the difference between pre- and post-dissemination scores'. The reference category for this model is the 'control' group, marked by * in the table.

Model 3b

Model 3b (Figure 5-45 and Table 5-14) showed that only the 'village meeting and video' method, had a significant positive association ($p<0.0001$) on the change in mastitis knowledge of an individual when compared to the 'village meeting' method of dissemination. In addition, a positive association of borderline significance ($p=0.0584$) was seen with the 'handout' method of dissemination. This model demonstrated that, in addition to being effective compared to the control group, the ability of the dissemination method 'village meeting and video' to change mastitis knowledge was also more effective than the 'village meeting' method. In addition, this model showed that the control group had a significant negative effect on the change in mastitis knowledge of an individual, when compared to the 'village meeting' method of dissemination.

A further model (not shown), in which all dissemination methods were compared to the reference category of 'village meeting and handout', showed that ability of the dissemination method 'village meeting and video' to change mastitis knowledge was no more effective than the 'village meeting and handout' method.

$$\text{scoredifference}_{farm\ village} \sim N(XB, \Omega)$$

$$\begin{aligned}\text{scoredifference}_{farm\ village} = {} & \beta_{0farm\ village}\text{cons} + -8.500(1.635)\text{control}_{village} + \\ & 4.429(1.635)\text{methodvmeetingandvideo}_{village} + \\ & 2.571(1.635)\text{methodvmeetingandtext}_{village} + 3.095(1.635)\text{methodtext}_{village} + \\ & 2.667(1.635)\text{methodvmeetingvideoandtext}_{village}\end{aligned}$$

$$\beta_{0farm\ village} = 11.191(1.156) + u_{0village} + e_{0farm\ village}$$

$$\left[u_{0village}\right] \sim N(0,\ \Omega_u) : \Omega_u = \left[4.935(1.907)\right]$$

$$\left[e_{0farm\ village}\right] \sim N(0,\ \Omega_e) : \Omega_e = \left[21.598(2.078)\right]$$

$-2*loglikelihood(IGLS) = 1517.852(252 \text{ of } 252 \text{ cases in use})$

Figure 5-45: Multilevel Model 3b for dissemination methods associated with the change in mastitis knowledge of an individual, defined by 'the difference in pre- and post-dissemination scores'. The reference category in this model is the 'village meeting' method of dissemination. 'Text' refers to the project handout.

Regression terms	*Estimates*	*S.E.*	*P Value*
Random effects	*Variance estimate*		
Village	4.935	1.907	
Farm	21.598	2.078	
Fixed effects	*Coefficients*		
Dissemination method			
-Control	-8.500	1.635	<0.0001
-Village meeting and video	4.429	1.635	0.0068
-Village meeting and handout	2.571	1.635	0.1158
-Handout	3.095	1.635	0.0584
-Village meeting*			
-Village meeting, video and handout	2.667	1.635	0.1028

Table 5-14: Multilevel Model 3b for dissemination methods associated with a change in mastitis knowledge of an individual, defined by 'the difference in pre- and post-dissemination scores'. The reference category for this model is the 'village meeting' method, marked by * in the table.

Further univariable analysis showed that other variables also had significant positive associations with a change in mastitis knowledge, including the respondent volunteering post-dissemination, in response to the question "How did you learn about mastitis?" that they had learned from DFID training. Positive associations were also seen with respondents who had received higher education, when compared to standard level education; and respondents who had owned their dairy animals for either 0 to 1 year, or 2 to 5 years, when compared to those respondents who had owned their animals for more than 5 years (Table 5-15).

A significant negative association with the pre-dissemination score obtained by a respondent was also demonstrated. In addition, significant negative associations were seen for a respondent volunteering that their cow had suffered from mastitis during either the pre-dissemination questionnaire or the post-dissemination questionnaire, the number of dairy cattle owned by a respondent, and whether the HIT or TWIT loan had been repaid (Table 5-15).

Other variables had been included in the original hypothesis for a change in mastitis knowledge, but were excluded following demonstration of a weak association ($p>0.25$) during univariable analysis. These included the gender of the respondent; the role of the respondent within the household; illiteracy of the respondent; concurrent ownership of local cattle; sourcing the dairy cow either privately or through a HIT or TWIT credit; rural, peri-urban or urban location, whether the respondent was responsible for the main dairy activities on the farm, whether the respondent was responsible for milking on a regular or occasional basis, whether an attendant was employed on the farm, and whether the attendant was responsible for milking. Such variables were therefore excluded from further analysis.

Fixed effect	*Coefficient*	*S.E.*	*p value*
Pre-dissemination score	-0.688	0.097	<0.0001
Methods of learning about mastitis volunteered (post)			
-Learned from nowhere *			
-Learned from Buhuri	0.745	0.765	0.3301
-Learned from EO	-0.297	0.958	0.7565
-Learned from DFID training	2.552	0.833	0.0022
-Learned from other training course	-0.229	1.646	0.8894
-Learned from other farmer	-0.109	1.797	0.9516
-Learned from mastitis case	0.649	1.366	0.6347
-Learned from pamphlet	1.484	1.845	0.4212
Education level			
-None	-1.540	1.823	0.3982
-Standard*			
-Form	0.310	0.799	0.6980
-Higher	1.394	0.864	0.1067
Length of time owning dairy cattle			
0 to 1 year	2.291	1.295	0.0769
1 to 2 years	1.131	1.096	0.3021
2 to 5 years	1.656	0.741	0.0254
Over 5 years*			
Cow suffered from mastitis (post)	-2.054	0.640	0.0013
Repaid loan	-2.235	0.776	0.004
Number of dairy cattle owned	-0.460	0.206	0.0255
Cow suffered from mastitis (pre)	-2.105	0.634	0.0009

Table 5-15: Further significant explanatory variables for the outcome variable 'difference between pre- and post-dissemination scores' following univariable analysis, with fixed effects of farm and village. The reference category of a group of dummy variables is marked by * in the table.

Multivariable analysis

A third model was then used to estimate the contribution of explanatory variables to the change in mastitis knowledge of an individual. This combined the dissemination methods in Model 3a with further explanatory variables, in order to provide a final multilevel model (Model 3c) to describe the outcome variable 'difference in pre- and post-dissemination scores', with the random effects of village and farm taken into consideration, and allowing for residual confounding from other variables. Multivariable analysis was done by fitting more than one variable into the model adopting a backwards stepwise elimination procedure. Final estimation of all models was done using the RIGLS method.

Model 3c – Final multilevel model

The final multilevel model (Figure 5-46 and Table 5-16) for change in mastitis knowledge, defined by 'the difference between pre- and post-dissemination scores' with random effects of village and farm, included positive associations with all of the five dissemination methods, 'village meeting and video', 'village meeting and handout', 'handout', 'village meeting' and 'village meeting, video and handout' dissemination methods, when compared to the 'control' group. This suggests that the five dissemination methods were effective at changing mastitis knowledge compared to the control group (Table 5-16).

A positive association was also seen when the respondent volunteered post-dissemination, in response to the question "How did you learn about mastitis?", that they had learned from a Buhuri training course, project (DFID) training, or a pamphlet (Table 5-16). Significant positive associations were also seen with respondents who had received 'higher' level education, when compared to 'standard' level.

A significant negative association was seen with the pre-dissemination score obtained by a respondent (Table 5-16).

$$scoredifference_{farm,\ village} \sim N(XB,\ \Omega)$$

$$\begin{aligned} scoredifference_{farm,\ village} = {} & \beta_{0farm,\ village}cons + 10.985(1.257)vmeetingvideo_{village} + \\ & 10.367(1.229)vmeetingtext_{village} + 10.759(1.231)text_{village} + \\ & 7.901(1.226)vmeeting_{village} + 10.398(1.257)vmeetingvideotext_{village} + \\ & -0.859(0.097)scorepre_{farm,\ village} + 1.743(0.660)buhuripost_{farm,\ village} + \\ & 0.004(0.834)eopost_{farm,\ village} + 1.459(0.721)dfidpost_{farm,\ village} + \\ & 1.035(1.476)othtrainingpost_{farm,\ village} + 0.069(1.551)farmerpost_{farm,\ village} + \\ & 0.950(1.191)casepost_{farm,\ village} + 3.198(1.587)pamphletpost_{farm,\ village} + \\ & -2.132(1.573)none_{farm,\ village} + 1.134(0.674)form_{farm,\ village} + \\ & 3.208(0.781)higher_{farm,\ village} \end{aligned}$$

$$\beta_{0farm,\ village} = 6.045(1.092) + u_{0village} + e_{0farm,\ village}$$

$$\left[u_{0village}\right] \sim N(0,\ \Omega_u) : \Omega_u = \left[1.950(1.051)\right]$$

$$\left[e_{0farm,\ village}\right] \sim N(0,\ \Omega_e) : \Omega_e = \left[16.802(1.617)\right]$$

$-2*loglikelihood(IGLS) = 1430.572(252$ **of 252 cases in use)**

Figure 5-46: Final multilevel Model 3c for variables associated with a change in mastitis knowledge of an individual, defined by the 'difference in pre- and post-dissemination scores'. 'Text' refers to the project handout.

Regression terms	*Estimates*	*S.E.*	*Overall p value (for group of dummy variables)*	*p value*
Random effects				
Village	1.950	1.051		
Farm	16.802	1.617		
Fixed effects				
Dissemination method				
-Control*				
-Village meeting and video	10.985	1.257		<0.0001
-Village meeting and handout	10.367	1.229		<0.0001
-Handout	10.759	1.231		<0.0001
-Village meeting	7.901	1.226		<0.0001
-Village meeting, video and handout	10.938	1.257		<0.0001
Methods of learning about mastitis volunteered (post)				
-Learned from nowhere *				
-Learned from Buhuri	1.743	0.660		0.0083
-Learned from EO	0.004	0.834		0.9962
-Learned from project (DFID) training	1.459	0.721		0.0430
-Learned from other training course	1.305	1.476		0.4832
-Learned from other farmer	0.069	1.551		0.9645
-Learned from mastitis case	0.950	1.191		0.4251
-Learned from pamphlet	3.198	1.587		0.0439
Pre-dissemination score	-0.859	0.097		<0.0001
Education level				
-None	-2.132	1.573		0.1753
-Standard* (primary)				
-Form (secondary)	1.134	0.674		0.0925
-Higher	3.208	0.781		<0.0001

Table 5-16: Final multilevel Model 3c for variables associated with a change in mastitis knowledge of an individual, defined by the 'difference in pre- and post-dissemination scores'. The reference category of a group of dummy variables is marked by * in the table.

5.5 Discussion

The aim of this phase of the study was to evaluate the effectiveness of different methods for direct dissemination of mastitis knowledge to individual respondents. Assessment was based on practices and knowledge recalled by respondents in relation to milking hygiene and mastitis, rather than on direct observation of respondents' practices. It is not, therefore, possible to draw conclusions about the effect of dissemination methods on actual 'on-farm practices' carried out by respondents. In addition, evaluation of the dissemination methods was done on a short-term basis, at an interval of one to two weeks after dissemination, thus conclusions cannot be drawn about the long-term efficacy of the methods use

5.5.1 Impact of dissemination

Results of Models 1 and 2 showed that all of the dissemination methods used, 'handout', 'village meeting', 'village meeting and video', 'village meeting and handout', and 'village meeting, video and handout' had a positive association with 'the overall mastitis knowledge of a respondent' compared to the control group, which suggest that they were effective at disseminating mastitis knowledge. In addition, results showed that the 'handout', 'village meeting and video', 'village meeting and handout', and 'village meeting, video and handout' methods were more effective than the 'village meeting' method at disseminating mastitis knowledge. Results also suggested that the dissemination methods used by the study were more effective than those by which respondents had previously learned about mastitis. The 'Hawthorne control' group was also shown to be non-significant compared to the 'control group'.

Results of Model 3 demonstrated that all five methods of dissemination used in the study were more effective than the 'control' group in causing a 'change in mastitis knowledge of a respondent', which was seen as increase in mastitis knowledge, with changes in pre- and post-dissemination scores ranging from 7.90 to 10.99 points above that of control group respondents (6.05). In addition, the 'village meeting' was shown to be inferior to the other four dissemination methods, namely 'village meeting and video', 'village meeting and handout', 'handout' and 'village meeting, video and handout'. The 'village meeting and video' method was also shown to be significantly better than both the 'control' group and the 'village meeting' method of dissemination in changing mastitis knowledge, but was not significantly better than the 'village meeting and handout', 'handout' and 'village meeting, video and handout' methods.

Results of multilevel modelling, therefore, suggest that 'village meeting' was the least effective of the five dissemination methods used by the study, and also that there was no significant advantage in the combination methods of dissemination 'village meeting and video', 'village meeting and handout' or 'village meeting, video and handout' over using the 'handout' method in isolation.

Results of statistical modelling, plotted as horizontal error bars, illustrated that there was variation between mastitis facts in both the overall success of dissemination, and in the method of dissemination that proved to be most successful for dissemination of each fact. Descriptive statistics showed that the baseline level of respondents' knowledge about mastitis facts was generally poor, although variation between facts was also seen.

Direct comparison of the findings that the dissemination methods 'handout', 'village meeting', 'village meeting and video', 'village meeting and handout', and 'village meeting, video and handout' were effective at disseminating mastitis knowledge compared to the control group cannot be made to other studies, as there are no similar published studies in the field of agriculture, and no references to studies which used these methods of dissemination have been found. Other studies have, however, shown that video can be an effective method of knowledge dissemination, both in isolation (Mitchell et al., 2001; Torabi et al., 2000; O'Donnell et al., 1998), and also in combination with comic books (Yuan et al., 2000), with lectures and practical classes (Tender et al., 2001), and with booklets and counselling (Windsor et al., 2000). Due to practical and logistical constraints, this study was unable to use 'video' in isolation as a dissemination method, and conclusions cannot therefore be made about the efficacy of 'video' alone as a dissemination method. A medical study into HIV/AIDS, however, found that 'video', and 'video plus group discussion' interventions were both effective in increasing knowledge when compared to the control group, but that there was no significant difference between the two interventions (O'Donnell et al., 1998).

Results of this study have shown that the 'handout' method of dissemination was extremely successful, and equally as effective as the 'village meeting and video', 'village meeting and handout', and 'village meeting, video and handout' methods in disseminating mastitis knowledge. This suggests that the combination methods used by the study showed no benefit over 'handout' alone. The success of the 'handout' method in isolation was a surprise to the author, and contrary to the views of other authors (Windsor et al., 1984, cited by Mitchell et al, 2001; Green et al, 1980, cited by Mitchell et al, 2001; Clarke, 1987, cited by Mitchell et al., 2001) and the findings of the most comparable previous studies, which showed that booklets had only a minimal impact on knowledge and attitudes (Harvey et al., 2000), and leaflets achieved high levels of exposure, but low levels of knowledge dissemination (Mitchell et al., 2001). It should, however, be noted that the 'handout' method referred to throughout this chapter took the form of a diagrammatic handout (or booklet), with simple Kiswahili text annotation. This handout was personally distributed to each farmer by the author and co-facilitator, and a brief explanation of the diagrams was given at the time of distribution. This was done mainly to explain the 'arrow format' of the diagrams, as it was found that some respondents found these difficult to follow, a finding which concurs with other authors (Harford and Baird, 1997; Linney, 1995). It should be noted, however, that discussion about mastitis was not entered into at the time of distribution, and respondents also asked very few questions. For this reason, the 'handout' method of dissemination in this project may not conform to the standard interpretation of a booklet or handout, as there was a small amount of personal contact and explanation given at the time of distribution. This may have contributed to the success of the handout as a dissemination method, as it has been shown that short periods spent explaining pictures to respondents can improve their visual literacy skills (UNICEF, 1976, cited by Linney, 1995).

The success of the project handout as a dissemination method may also have been due to the inclusion of important design factors that have been identified by other authors. These include the fact that the handout comprised simple line drawings with shading (Garforth, 1985; Byram and Garforth, 1980; Unicef, 1976, cited by Linney, 1995; Cook, 1984, cited by Linney, 1995), minimal explanatory text (Byram and Garforth, 1980) situated close to images (Mayer, 1999), and images which were locally relevant to respondents (Linney, 1995; Byram and Garforth, 1980; Garforth and Usher, 1997; Harford and Baird, 1997). In addition, the project handout may have been highly valued by respondents, as it has been noted that many houses, particularly in rural areas, contained very little printed material (Bell, personal observation, 1999), a finding which concurs with those of other studies which showed that access to printed material was low (Byram and Garforth, 1980; Garforth, 1985), and that two-thirds of households had no books, magazines or other printed material in their homes (Byram and Garforth, 1980). The success of the 'handout' in combination with either a 'village meeting', or 'village meeting and video' may have been a result of reinforcement of points made during the video or meeting by the handout, and also provision of a permanent source of reference for respondents, as these factors are considered to be important by other authors (Mitchell, 2001; Kroenke, 1991; Byram and

Garforth, 1980). The success of the 'handout' method of dissemination also conflicts with the views of Mitchell (2001) who suggests that dissemination methods that provide an opportunity to ask questions are more likely to be successful than methods that do not allow questioning.

Results showed that the 'village meeting' method of dissemination was less effective than the other dissemination methods used in the study. This finding may be partly explained by those of other studies concerning the use of multimedia as education methods, which have shown that students understanding of concepts was better when they received both verbal, and visual, information about a subject. It is thought that learners have separate visual and verbal processing systems which interact both with each other, and with prior knowledge, to facilitate cognitive learning (Mayer, 1999). Learning has also been found to be further enhanced when visual and verbal information is received simultaneously (Mayer, 1999). It can be hypothesised that the 'village meeting' method provided only verbal information, in contrast to the 'village meeting and video', 'village meeting and handout', and 'village meeting, video and handout' methods which provided simultaneous visual, and verbal, information about mastitis. This hypothesis would not, however, explain the success of the 'handout' method of dissemination, as this would have only provided visual information. A further hypothesis, however, may be that the 'handout' provided a reference source which respondents could refer back to at their convenience, in contrast to information disseminated at the 'village meeting' which was provided verbally on only one occasion. Byram and Garforth (1980) refer to the importance of a visual reference document that can be kept.

Results for Models 1, 2 and 3 showed that the variables associated with previous methods of learning about mastitis, including 'from a Buhuri training course, project (DFID) training, another training course, or a pamphlet', showed positive associations with both overall mastitis knowledge, and a change in mastitis knowledge of a respondent. Results showed that these variables had significant odds ratios (Models 1 and 2), or significant coefficients (Model 3), which were much lower than those obtained for the five dissemination methods used in the study. These findings, therefore, suggest that previous methods of dissemination to which the respondent had been exposed had limited additional impact after allowing for the five dissemination methods used in the study. It must, however, be acknowledged that these variables were dependent on respondent recall, and may, therefore, not accurately represent the actual methods to which each respondent had been exposed. In addition, such methods were probably not specifically targeted towards mastitis, and rather to animal disease in general.

It was interesting to find that multilevel models showed the 'Hawthorne' control group to be non-significant, suggesting that administration of the pre-dissemination questionnaire had no significant effect on respondent's subsequent knowledge about mastitis. This finding is contrary to suggestions by other authors that the act of questioning may itself lead to higher levels of knowledge and comprehension than would otherwise have occurred (Byram and Garforth, 1980).

5.5.2 All responses – post dissemination

This study revealed that, in general, there was a higher proportion of 'volunteered' responses, and a lower proportion of 'no' and 'unsure' responses, for mastitis facts of interest amongst respondents in the dissemination groups, when compared to those in the control groups. This suggests that the knowledge of dissemination group respondents was generally greater than that of control group respondents, and that the dissemination methods used in the project were, therefore, effective.

The use of 'volunteered', 'prompted', 'no' and 'unsure' responses was chosen in an effort to assess both the knowledge which respondents could spontaneously recall from memory, and also knowledge which was present but required prompting to initiate recall. Prior to the onset of the study, it was assumed that 'prompted' answers would indicate that a respondent was aware of a particular mastitis fact, even if they were unable to volunteer it. It was hoped that such responses, in combination with 'volunteered' responses, would give an overall indication of the level of knowledge about a mastitis fact within the study population. As the study progressed, however, it became clear that whilst 'volunteered' responses gave an unambiguous assessment of a respondent's knowledge, 'prompted' answers may have had a number of complications associated with them.

The results of this study indicated that there were a higher proportion of 'prompted' answers in the control groups than in the dissemination groups. This may be accounted for by the fact that, as response types were mutually exclusive, any increase in the proportion of 'volunteered' responses seen in the dissemination groups, would automatically lead to a decrease in the proportion of 'prompted' responses. It may also be hypothesised from these results that prompting of control group respondents may have lead to stimulation of existing knowledge in respondents. An alternative hypothesis may, however, be that control group respondents were simply answering 'yes' to all facts on prompting, regardless of knowledge or logical reasoning. This leads to the possible conclusion that 'prompted' responses may, therefore, be an inaccurate method of evaluating a respondent's knowledge. It was also shown, however, that when respondents were asked about facts classified as 'validation variables', results indicated that respondents answered 'no' to facts that they did not associate with mastitis, and, therefore, did not simply answer 'yes' for all facts. This result leads to the tentative conclusion that, in addition, to 'volunteered' answers, the 'prompted' answers given by respondents provided an additional assessment of a respondent's true knowledge. Due to these conflicting conclusions, however, it was decided to only use 'volunteered' answers for the majority of data analysis in this study, as these were known to provide a consistent, and accurate, assessment of a respondent's true knowledge. In the future, the cognitive processes associated with a respondent giving a 'volunteered' or a 'prompted' answer should be considered further.

Of interest were the results obtained for the fact 'decreased milk yield', which had been included during dissemination as both a 'sign of mastitis', and an 'effect of mastitis'. Results for 'decreased milk yield' as both a 'sign of mastitis', and an 'effect of mastitis', showed statistical significance between 'prompted' answers from control and dissemination group respondents, however, there was no significant difference between 'volunteered' answers. This suggests that respondents were aware of an association between mastitis and a 'decreased milk yield', but may have been uncertain as to which category the fact should be classified under. This may have been a result of inclusion of 'decreased milk yield' as an 'effect of mastitis' on the project poster, and also as a 'sign of mastitis' on the project diagrammatic handout.

It was encouraging to see that a number of the facts concerning 'effects of mastitis' showed highly significant differences ($p<0.001$) between 'volunteered' answers from control and dissemination group respondents. This suggests that dissemination of these facts was highly successful in the short term, which may have been attributable to their inclusion on the project poster. It may be hypothesised that the poster provided an easily accessible, attractive, pictorial reminder of the 'effects of mastitis' each time it was observed by a respondent.

Of further interest, was the low number of volunteered responses obtained for facts concerning the 'spread of mastitis' amongst control group respondents. This suggests that there was poor baseline knowledge about these facts amongst respondents, a finding that had been confirmed verbally by respondents during village meetings. Results showed that dissemination of facts concerning the 'spread of mastitis' was successful, with eight of the ten facts (excluding validation variables) showing significant ($p<0.01$) differences between 'volunteered' answers from control and dissemination group respondents. In addition, there were extremely low proportions of 'no' and 'unsure' responses amongst the dissemination groups, most of which were statistically significant ($p<0.01$) when compared to those of control groups. In contrast, 'no' and 'unsure' answers for 'validation variables' showed no significant differences between control and dissemination groups. This finding supports the conclusion that dissemination group respondents' knowledge of facts concerning the 'spread of mastitis' was greater than that of control group respondents, indicating that the study had been successful in the dissemination of these important facts.

In contrast, results for dissemination of facts concerning the 'prevention of mastitis' showed more variable success than those concerning the 'spread of mastitis'. Results show that the dissemination of certain facts was successful, with statistically significant increases in the proportions of 'volunteered' answers seen between dissemination group respondents when compared to those in control groups. Other facts, however, showed evidence of poor dissemination, including the recommendations that 'only the teats of the udder should be washed', and the 'udder should be dried using a hand'. A further finding of interest was the suggestion that respondents' perception of the importance of 'complete milking' as a method of prevention of mastitis had decreased following dissemination. Prior to dissemination, it was noted that 'complete milking' appeared to be respondents' main perceived method of prevention of mastitis, and it was established that this fact had been taught to attendants of the farmers training courses at LITI Buhuri. One hypothesis for this finding may be that following dissemination, respondents were aware that other methods of mastitis prevention may have been more important than that of complete milking, or an alternative hypothesis may be that project dissemination methods inadvertently understated the importance of 'complete milking' as a method of prevention of mastitis. The results seen for the fact 'use clean water' may have been a result of the questioning technique, as respondents were asked 'Is the water you use to wash the udder important?'. A number of respondents responded that the water should be warm, but did not mention that it should also be clean, and such responses were therefore recorded as 'no'. It can be postulated that a different response may have been given in answer to the question 'Is it important to use clean water?', however this was felt to be a leading question. All responses for facts concerning the 'prevention of mastitis' showed a small number of 'no' responses, and an extremely low number of 'unsure' answers amongst dissemination group respondents, suggesting that dissemination had increased respondents' confidence in their own knowledge.

5.5.3 Volunteered responses – pre- and post-dissemination

Results concerning respondents' knowledge, and sources of knowledge, about mastitis show that the majority of respondents (91%) had heard of mastitis prior to dissemination, however, further questioning revealed that 26% of respondents stated that they had not learned about the disease by any specified method. These facts may be explained by the compulsory attendance by all HIT or TWIT farmers at a two-week LITI Buhuri training course prior to receiving their cow. This course covered all aspects of dairy cattle keeping, including a brief focus on mastitis. In contrast, farmers who purchased their cattle privately received no formal training, and thus may account for those respondents who indicated that they had not learned about mastitis by any specified method. In addition, although the family member responsible for the main dairying activities was targeted as the respondent for this study, a different family member may have attended the LITI Buhuri training course, for reasons described previously.

Prior to dissemination, the perceived importance of the EO as a method of learning about mastitis was relatively high (26%), however following dissemination this proportion had fallen in both the control (11%) and dissemination groups (16%). Amongst dissemination group respondents this maybe explained by the large rise in the perceived importance of project (DFID) training (29%), which may have resulted in an associated reduction in the perceived importance of the EO.

For the categories 'signs', 'effects', 'spread' and 'prevention' of mastitis, a proportion of pre-dissemination respondents volunteered that they were 'unsure' of the topics, and, were therefore, unable to volunteer any responses to the questions. Following dissemination, however, it was seen that none of the respondents, in the 'control' and 'Hawthorne control' groups, or the dissemination groups, volunteered that they were 'unsure' of the topic. This may have been due to the difference in questionnaire administration methods between pre- and post-dissemination groups. In both cases, questions were read out by the project co-facilitator, however, this was done in a group format for the pre-dissemination questionnaire and responses were written by the respondent, whilst post-dissemination questionnaires were conducted by personal interview, and responses were recorded by the author.

It was extremely encouraging that dissemination of the three key recommendations associated with the 'identification of mastitis' was found to be extremely successful. The proportion of dissemination group respondents volunteering the facts 'look at the udder', 'palpate the udder' and 'check the foremilk' post-dissemination, was much greater than that of pre-dissemination respondents. Of the three methods recommended, 'checking the foremilk' showed the most successful dissemination, with 61% of respondents volunteering this fact post-dissemination, compared to 5% of pre-dissemination respondents. It was, however, also seen that there was an increase in the number of control group respondents volunteering these facts during the 'post-dissemination' questionnaire, when compared to pre-dissemination responses. In the absence of the multi-level model results, a possible hypothesis for this finding may have included the 'Hawthorne effect', however, the multilevel model showed this to be non significant. An alternative hypothesis, however, may be that the different methods of administration of pre- and post-dissemination questionnaires had an influence on responses.

It was interesting to find that dissemination of facts concerning the 'prevention of mastitis' showed variable efficacy, with facts including 'use one cloth per cow', 'use one corner of the cloth per teat' and 'ensure good hygiene of the banda, milker and udder cloth' being successfully disseminated to respondents, whilst other facts, including 'wash the teats only', 'wash the udder using hands' and 'dry the udder using hands' were not successfully disseminated. Acceptability of facts to farmers has been may have been responsible for these findings, as during dissemination it was found that many respondents appeared to disagree with those facts which subsequently showed unsuccessful dissemination.

5.5.4 Evaluation of the impact of dissemination by statistical modelling – odds ratios

Data analysis for this section used only volunteered answers from respondents, and took into account 'village' as a random effect. Results showed that there was marked variation in the efficacy of each dissemination method, depending on the mastitis fact being disseminated. Results for all mastitis facts showed that the 'Hawthorne control' group showed no significant difference in dissemination ability over the 'Control' group

Results associated with the 'identification of mastitis' showed there was variable efficacy between dissemination methods, however, it was seen that dissemination of the fact 'check foremilk' was performed best by methods that involved a village meeting. This may be explained by the fact that this point was emphasised strongly during village meetings, but was mentioned only once in the handout. None of the methods were effective in disseminating the fact 'seek advice' following identification of mastitis, a finding which concurs with other results concerning this fact.

Similarly, dissemination of facts concerning the 'signs of mastitis' also showed variation in efficacy. All methods were effective in disseminating the fact that a 'hot udder' was a sign of mastitis, with 'village meeting and video' proving to be the most effective method, followed by 'village meeting, video and handout' This finding was of interest, as a hot udder was not visually illustrated on the video, however, it was mentioned during narration, and was also discussed during the village meetings. It may be hypothesised that a practical class involving a clinical case of mastitis would have been the best method of dissemination of this fact, however, these results suggest that other non-practical methods were also effective.

In contrast to the previous fact, none of the methods used were significantly better than the control group in the dissemination of a 'swollen udder' as a sign of mastitis. This was of interest, as it was felt that this fact was well illustrated in the handout, and was also mentioned during the village meeting, and the video, however the baseline level of knowledge concerning this fact was relatively high, which may explain why a significant effect of dissemination was not seen. In a similar fashion, the baseline level of knowledge was high for a 'painful udder' being a sign of mastitis, and results showed that only the 'handout' method was significant in disseminating this fact. This finding may be explained by the fact that the handout showed a clear image of a cow kicking, in contrast to the video where this fact was mentioned, but an example of a cow kicking was not shown. All three methods of dissemination which were significant for disseminating a 'discoloured udder' as a sign of mastitis included the handout, in which a clear illustration of this fact showed an image of a cow with a bright red udder. Dissemination of 'clots in milk' as a sign of mastitis showed significant effects with 'village meeting and video', 'handout', village meeting, video and handout' and 'village meeting' methods. These findings were of interest, as the video showed a clear image of clots in the milk, however, it appears that discussion of this fact during village meetings, and inclusion of the fact in the handout were also effective methods of dissemination.

All five dissemination methods were significant in dissemination of almost all facts concerning the 'effects of mastitis', with the exception of a 'decreased milk yield'. This may partly be explained by the fact that the effects of mastitis were also included on the project poster, which was distributed to all dissemination group respondents. As mentioned previously, there appeared to be confusion amongst respondents as to whether to define a 'decreased milk yield' as a 'sign', or an 'effect' of mastitis.

Dissemination of facts associated with the 'prevention of mastitis' showed marked variation according to the fact of interest. The advice to 'use one corner of the cloth per teat' showed significant association with the 'village meeting and video', 'village meeting, video and handout' and 'village meeting' methods. This may be explained by inclusion of an extremely clear illustration of this fact during the video screenings, in addition to a visual demonstration during village meetings, however, this was contradicted by the fact that the 'village meeting and handout' method showed no significant effect of dissemination. Using a 'complete milking technique' showed negative associations with all five dissemination methods, however, the only one of statistical significance was the 'village meeting' method. This fact has been discussed previously.

5.5.5 Evaluation of the impact of dissemination by statistical modelling – multilevel modelling

Multilevel statistical models were used to analyse the association between explanatory variables and the overall mastitis knowledge of a respondent, defined by 'volunteering mastitis facts post-dissemination', and the change in mastitis knowledge of a respondent, defined by 'the difference between pre- and post-dissemination scores'. Thus data analysis for this section used only 'volunteered' answers from respondents. Multilevel models were selected, as it was desirable to analyse the data whilst considering certain random effects, in addition to possible confounding factors within the data.

Results of both Model 1 and Model 2 showed that most variation occurred at the level of individual question, reflecting the considerable variation between individual responses to each question. Results of Models 1, 2 and 3 also showed that all of the five dissemination methods demonstrated significant odds ratios, suggesting that they were effective at influencing both overall mastitis knowledge, and a change (increase) in mastitis knowledge compared to the control group. Odds ratios for the 'village meeting and video', 'village meeting and handout', 'handout' and 'village meeting, video and handout' methods were all similar, whilst the 'village meeting' method showed the lowest odds ratio. Results of Model 1b showed that the dissemination methods 'village meeting and video', 'handout' and 'village meeting, video and handout', were more effective at influencing overall mastitis knowledge than the 'village meeting' method of dissemination, whilst Model 2b showed that in addition, the 'village meeting and handout' method was also more effective than the 'village meeting' method of dissemination. Results of Model 3b showed that the 'village meeting and video' method was significantly more effective than the 'village meeting' method in influencing a change (increase) in mastitis knowledge, whilst the 'handout' method showed borderline significance. These results, therefore, suggest that 'village meeting' was the least effective of the five dissemination methods used by the study, and also that there was no significant advantage in the combination methods of dissemination 'village meeting and video', 'village meeting and handout' or 'village meeting, video and handout' over using the 'handout' method in isolation.

The results of univariable and multivariable analysis for Model 1 showed a high level of consistency, with the only one variable, 'age' of the respondent, being found to be significant on univariable analysis, but non-significant on multivariable analysis, which, therefore, excluded it from the final multivariable model. In contrast, the results of univariable and multivariable analysis for Model 2 showed less consistency, and again 'age' of the respondent, in addition to 'gender' of the respondent, 'repayment of HIT/TWIT loan', and the respondents 'role' in the household, were all found to be significant on univariable analysis, but non-significant on multivariable analysis, and were thus excluded from the final multivariable model.

Univariable analysis for Model 1 also showed significant positive associations with the categories of question type, 'identification', 'action taken', 'signs', 'effects' and 'spread', when compared to the 'prevention' category, with odds ratios ranging from 1.61 to 4.37. This suggested that respondents were able to answer certain question types better than others, and this finding was confirmed by the final multivariable model (Model 1c) which showed significant positive associations with the categories of question type, 'signs' (OR=1.96), 'effects' (OR=2.42) and 'spread' (OR=2.42), when compared to the 'prevention' category, but interestingly showed a significant negative association with the 'identification' (OR=0.76) category of question, and no significant association with the 'action taken' category of question. These results may be partly explained by the acceptability of the facts to respondents, or the efficacy of the dissemination materials used to disseminate these facts.

Models 1 and 2 both showed significant positive associations with respondents who had received 'form' or 'higher' level education, compared to 'standard' level, whilst Model 3 showed a significant positive association with respondents who had received 'higher' level education, compared to 'standard' level. These results suggest that the level of school education attained by a respondent had an important influence on their ability to learn new information as an adult. This may be due to literacy skills, visual literacy skills, general familiarity with education methods, or the ability to interpret material contained within them (Harford and Baird, 1997; Linney, 1995).

In addition, Models 1 and 2 both showed that the level of pre-dissemination baseline knowledge about a fact, represented by 'the percentage of respondents able to volunteer the specific mastitis fact pre-dissemination', was also important, suggesting that the higher the proportion of respondents who were aware of the fact pre-dissemination, the more likely a respondent was to volunteer a correct mastitis fact. This finding concurs with previous educational research that has shown that the baseline level of knowledge about a topic is important for learning, as information received by respondents is forgotten unless it can be rehearsed, or transferred to the long-term memory, and this process is related to the network of related concepts and facts already stored there (Brown, 1978; Nuthall, 1999). Results of Model 3, however, conflict with this finding, as they showed that the 'change in knowledge of a respondent' showed a significant negative association with the pre-dissemination score, which represented the number of facts a respondent was able to volunteer post-dissemination. This finding suggests that the level of change in mastitis knowledge decreased as the baseline level of knowledge increased, which implies that those respondents who had a poor baseline level of knowledge about mastitis were more likely to show an increased level of change of knowledge after dissemination than those respondents with a higher baseline level of mastitis knowledge.

Interestingly, all of the variables found to be significant in Model 1c, were also found to be significant in Model 2c, however in addition, Model 2c showed that there was a significant association with several other variables. These included a significant negative association with respondents from rural areas, a finding which concurred with the author's hypothesis that rural, peri-urban or urban location might have a significant effect on results. In addition, there was a positive association with a respondent 'volunteering that they had heard of mastitis post-dissemination, and with respondents who had owned their dairy cattle for between 2 and 5 years, compared to those who had owned their cattle for 5 years or more. The latter finding suggested that respondents' knowledge of disease may have deteriorated with time, perhaps due to a respondent forgetting details from the LITI Buhuri training course, showing disinterest in maintaining their knowledge, or being blasé about their knowledge. Model 2c also showed a positive association with a 'respondent milking occasionally', which initially seemed to be a counter-intuitive finding, however, it may be explained by the fact that this category contained a number of urban husbands or wives, who were only responsible for milking if their cowboy was unavailable. Many of these urban householders had received high levels of education, which may thus explain the significant positive association seen with a respondent volunteering a correct mastitis fact.

Some of the variables which were found to be non significant during univariable analysis of Models 1, 2 and 3 were of interest. This included the literacy of a respondent, as it had been hypothesised that illiteracy could have an important influence on the success of knowledge dissemination to a respondent. A possible explanation for this finding may be that the project had been successful in devising project dissemination materials that were understood by respondents of all literacy levels. It should also be noted, however, that results may have been influenced by the fact that this phase of the study contained only a small number of illiterate respondents, mainly because political and logistical reasons necessitated that heads of households were targeted for the study, many of whom had attained high levels of education. It had also been hypothesised that previous experience of a mastitis case may have a significant effect on respondents' knowledge, however results of multivariable analysis showed this to be non-significant.

6 GENERAL DISCUSSION

The results of this study are of particular interest as few controlled trials of knowledge dissemination methods have been published, particularly in the area of agricultural extension or animal disease. In addition, the randomised design of this study contributes to the validity of the findings.

It has been stated that smallholder farmers generally have poor access to information at the community level, and that this often results in decisions about animal health being based on very limited information (McDermott et al., 1999). In addition, it has been recognised that smallholder farmers are often constrained by limited opportunities to learn by direct observation of successful farmers, poor extension services and information systems, and lack of training in decision making (McDermott et al., 1999). It has also been stated that there is a general lack of knowledge about the most appropriate methods of delivery of effective extension services in Tanzania (Dulle and Aina, 1999).

One of the main aims of this study was, therefore, to develop novel methods for the dissemination of mastitis knowledge to smallholder farmers that were both effective and appropriate, and results of the study show that this was a major achievement. In addition, the study aimed to evaluate the effectiveness of these methods, and results of the study have enabled identification of the most effective overall methods of dissemination, in addition to the most effective methods for each individual mastitis fact.

In addition, results of the study have enabled identification of the most appropriate targets for mastitis dissemination programmes in the future, in addition to the most appropriate methods of dissemination to use for such programmes.

This study also demonstrated that 'diagrammatic handouts' were effective dissemination materials for short-term dissemination of mastitis facts, a finding that was contrary to both the author's hypothesis, and the findings of other studies.

6.1 Knowledge dissemination within communities of smallholder farmers in Iringa

One of the major findings of the study was the fact that cowboys were responsible for both cleaning the banda, and milking, on the majority of farms, and thus potentially had the most direct influence on the incidence of mastitis on the farm. It was also found that wives were responsible for supervision of these activities on the majority of farms and this leads to the conclusion that both cowboys, and wives, should be the targets for mastitis dissemination programmes in the future. In addition, the study found that the overall illiteracy rate amongst respondents was 7%, and amongst cowboys this figure was 12%, which suggests that methods employed in the future for disseminating information to target individuals should be carefully considered, and where appropriate, verbal, visual or diagrammatic methods should be employed.

The first part of the study implemented a mastitis training programme that aimed to increase the overall awareness of mastitis in the Iringa rural and urban districts of Tanzania, and to increase the mastitis knowledge of smallholder dairy farmers. Results of the study show that this was achieved, and that the overall ability of study respondents to volunteer a number of mastitis facts significantly increased between 1999 and 2000. A major finding of the study, however, was that the success of dissemination varied between facts.

Results of multi-level modelling showed that methods of dissemination that had a significant positive association with mastitis knowledge, one month after dissemination (short-term effect), were the MTC (OR=2.25), video screenings (OR=1.28), project pen (OR=1.34) and the EO (OR=1.17). This finding concurs with those of other studies which have shown video to be an effective method of dissemination (Mitchell et al., 2001; Torabi et al., 2000; O'Donnell et al., 1998), and the views of other authors that suggest that EO are effective sources of knowledge to farmers (Dulle and Aina, 1999).

Sixteen months after dissemination (long-term effect), the only methods of dissemination that were shown to have a significant positive association with mastitis knowledge were the MTC (OR=1.57) and the EO (OR=1.26). This suggests that the impact of the video screenings and the pen on mastitis knowledge had diminished over time. This finding may be associated with the number of times a mastitis fact was presented by each dissemination method, as studies have shown that an individual must be exposed to a representation of a fact on three or four separate occasions, within a period of two days, for a permanent representation of that fact to be constructed and transferred to the long-term memory (Nuthall and Alton-Lee 1993, cited by Nuthall 1999).

Results of multilevel modelling also showed significant positive associations between a respondent 'remembering the logo on the pen', or 'having seen the project logo elsewhere', and the respondent 'volunteering a correct mastitis fact'. This suggests that the project logo had a positive impact on mastitis knowledge, perhaps by stimulating thought or discussion about mastitis, however, comparable research concerning the effect of logos on knowledge was not available.

Comparison of both descriptive, and multilevel modelling results suggest that those methods which respondents perceived to be important sources of mastitis knowledge in the short-term, including the MTC and video, did actually show a significant positive association with respondents' mastitis knowledge. In contrast, those perceived to be important in the long-term, including project visits and posters, actually showed no significant association with mastitis knowledge.

The MTC, which formed a major part of the mastitis training programme, was shown to have a significant positive effect on participants' short-term and long-term mastitis knowledge. The impact of the MTC on the overall knowledge of the study population was, however, hindered by the lack of further dissemination undertaken by a proportion of the MTC participants. This was particularly true of urban VBAHW and FM participants, whose reasons for failing to further disseminate information included 'being unwilling to potentially increase their neighbours milk production, as this would provide competition for milk sales', 'being unwilling to disseminate the information to their cowboys, as this may increase their skills and result in them requesting a higher salary, or looking for a better job', and 'not knowing who their dairy farming neighbours were'. This lack of further dissemination concurs with the findings of Muhammad and Garforth (1998) who found that similar individuals, elected as 'contact farmers' for the propagation of agricultural information, served as a source of information to less than 3% of farmers.

Although descriptive findings suggested that the EO participants of the MTC had also made little effort to organise group meetings to further disseminate information, results of the multilevel modelling suggest that EO were a significant source of mastitis information to study farmers, a finding which concurs with the views of Dulle and Aina (1999). It is generally acknowledged that EO are the traditional providers of information to farmers in developing countries, (Dulle and Aina, 1999), and results of this study also suggest that EO are effective sources of mastitis knowledge. This study did, however, show that there was significant variation between EO in their effect on respondents' mastitis knowledge, and that individual EO could be identified who showed a negative association with mastitis knowledge when compared to the reference EO, who was widely considered to be one of the most capable EO in the area. The failure of certain individuals to further disseminate information may have resulted from inadequate emphasis of this matter by project PIs during the MTC, however, results associated with both the EO, and the VBAHW and FM participants of the MTC suggest that factors associated with the individual participant may also be important. This leads to the conclusion that selection of participants for a training course should be considered carefully, and efforts should be made to select motivated and enthusiastic individuals who are likely to be effective disseminators of information to their community. This observation concurs with findings of other authors (Mitchell et al., 2001; Muhammad and Garforth, 1998), which have shown that the selection of individuals for the propagation of information within a community has often been inappropriate, and ineffective. The MTC was shown to be effective in educating course participants about mastitis, and in addition the format for EO was considered to be appropriate, and a worthwhile investment with beneficial effects on the mastitis knowledge of the study population. The same conclusion could not, however, be drawn for VBAHW and FM, as no beneficial effects on the mastitis knowledge of the study population were demonstrated, and the money invested in the course (67,857 Tsh per participant) could perhaps have been put to better use.

The acceptability of different mastitis control measures to farmers has recently been studied by Karimuribo (2002). Only 10% of those interviewed stated that they regularly used a strip cup for mastitis detection and reasons given for this included that they only used the cup when mastitis was suspected, when the cow was sick or in early lactation only. Use was limited when a new cow attendant was caring for the cows, while other farmers stated they did not have a strip cup or that they simply found the technique too time-consuming. When farmers had used post-milking teat dipping, more than 70% continued to use it some months after the initial study ended. Reasons given by those who discontinued the technique included forgetting to do it, running out of teat-dip, having employed a new attendant or the cow being too aggressive to allow the procedure. These results indicate that there may be similar reasons for the uptake of certain techniques (e.g.

employment of new, untrained personnel) but that others differ depending on the particular preventive method introduced. In addition, it is thought that adults are more receptive to information when it is directly applicable to their situation (Bessoff, 1995).

6.2 Direct knowledge dissemination to a defined number of respondents

The second main phase of the study evaluated the effectiveness of different combinations of dissemination materials for dissemination of mastitis knowledge directly to an individual respondent. Knowledge of an individual respondent was defined by their ability to 'volunteer mastitis facts post-dissemination'.

The efficacy of dissemination varied widely according to the fact of interest. Multilevel statistical models looking at 'overall mastitis knowledge' also confirmed that variation was greatest at the level of 'individual question', which referred to 'an individual respondent being asked an individual question', suggesting that different questions were answered with varying success.

Multilevel models showed that the 'overall mastitis knowledge' of respondents who had been exposed to one of the five dissemination methods was greater (OR>2.61) than that of respondents in the control group. In addition, it was shown that the dissemination methods used were significantly different from each other in their ability to disseminate mastitis knowledge, with the methods 'village meeting and video', 'village meeting and handout', 'village meeting, video and handout', and 'handout' shown to be more effective than the 'village meeting' method.

Multilevel Model 1c, which included the random effects of individual question, farm, and village, showed that all five methods were significantly more effective in the dissemination of mastitis knowledge than the control group, with highly significant ($p<0.0001$) odds ratios being obtained for 'handout' (OR=3.50, 95% CI=3.10, 3.96), 'village meeting, video and handout' (OR=3.34, 95% CI=2.94, 3.78), 'village meeting and handout' (OR=3.28, 95% CI=2.90, 3.71), 'village meeting and video' (OR=3.22, 95% CI=2.84, 3.64), and 'village meeting' (OR=2.61, 95% CI=2.31, 2.95).

Multilevel Model 2c, which included the random effects of individual question, question number, and question type, also showed that all five methods were significantly more effective in the dissemination of mastitis knowledge than the control group, with highly significant ($p<0.0001$) odds ratios being obtained for 'handout' (OR=4.09, 95% CI=3.74, 4.47), 'village meeting, video and handout' (OR=3.93, 95% CI=3.59, 4.31), 'village meeting and handout' (OR=3.90, 95% CI=3.57, 4.26), 'village meeting and video' (OR=3.64, 95% CI=3.32, 3.99), and 'village meeting' (OR=2.96, 95% CI=2.71, 3.24).

Multilevel Model 3c looked at the 'change in mastitis knowledge' of an individual following dissemination, and results showed that all five methods of dissemination were significantly more effective than the control group, with highly significant ($p<0.0001$) coefficients being obtained for 'village meeting and video' (10.99), 'village meeting, video and handout' (10.94), 'handout' (10.76), 'village meeting and handout' (10.37), and 'village meeting' (7.90). These results suggest that respondents exposed to any one of the five dissemination methods would be likely to show a difference in pre- and post-dissemination scores at least 7.9 points greater than a respondent in the control group.

In addition, Models 1 and 2 showed that there was no significant association between the 'Hawthorne control' group and a respondent 'volunteering a correct mastitis fact post-dissemination'. This suggests that the administration of a questionnaire, comprising open-ended questions, had no effect on a respondent's subsequent ability to volunteer correct answers to identical questions.

Other variables which were shown by multilevel modelling to have significant positive associations with mastitis knowledge included the 'level of education of the respondent', 'previous methods of education about mastitis', 'number of years experience owning dairy cattle' and the 'level of baseline knowledge about a fact within the study population'. A small negative association was also seen with respondents who lived in 'rural' areas compared to those from 'urban' areas. The level of schooling achieved by a respondent may have been influenced by location, as it has been shown that rural areas generally have poorer access to schools, in particular to secondary schools (Swainson, 2000). Results of the study also showed that questions concerning 'signs', 'effects, and 'spread' of mastitis were answered better than those concerning 'prevention' of mastitis (the reference category), whilst those concerning 'identification' of mastitis showed a small negative association, and those concerning 'action taken on identification of mastitis' showed no significant difference.

Following dissemination, respondents in 'dissemination' groups generally showed a higher proportion of 'volunteered' answers, and a lower proportion of 'no' and 'unsure' answers than respondents in the 'control' groups, however, there was some variation between facts. Knowledge about facts concerning 'signs' of mastitis was generally good in both 'control' and 'dissemination' groups, whilst knowledge about facts concerning the 'spread' of mastitis was extremely poor amongst 'control' groups respondents, but good amongst 'dissemination' group respondents. Knowledge about facts concerning 'effects' of mastitis was generally poor amongst 'control' group respondents, and good amongst 'dissemination' group respondents, whilst knowledge about facts concerning 'prevention' of mastitis was generally poor amongst 'control' group respondents, and average amongst 'dissemination' group respondents.

Prior to dissemination, a number of respondents volunteered that they were unsure about certain mastitis topics, and were thus unable to volunteer any mastitis facts of interest, however, following dissemination, this proportion had decreased to almost zero amongst 'dissemination' groups. In general, following dissemination there was marked increase in the proportion of respondents in 'dissemination' groups able to volunteer mastitis facts of interest, when compared to 'control' groups and 'pre-dissemination' groups, however, the extent of the increase varied according to the mastitis fact of interest. Fact concerning the 'identification', 'signs', 'effects' and the 'spread' of mastitis' showed evidence of extremely successful dissemination, with marked post-dissemination increases in the proportion of 'dissemination' group respondents able to volunteer these facts compared to those of the 'pre-dissemination' group. Dissemination of facts concerning the 'prevention' of mastitis showed evidence of more moderate success

The change in knowledge of individual respondents, represented by pre- and post-dissemination scores, showed that the average change in score was greatest amongst those respondents exposed to the 'village meeting and video' method (15.6 points), of decreased, but similar, magnitude amongst those exposed to the 'handout' method (14.3 points), 'village meeting, video and handout' method (13.9 points), 'village meeting and handout' method (13.8 points), and least amongst respondents exposed to the 'village meeting' method (11.2 points). 'Control' group respondents also showed an average increase in score of 2.7 points.

Odds ratios, adjusted for the random effect of village, showed that all five dissemination methods showed significance for a respondent volunteering certain facts of interest when compared to control group respondents, however, again there was variation between facts. It was shown that the most effective method of dissemination also varied between facts.

Prior to dissemination, it was noted that 'complete milking' appeared to be the main perceived method of prevention of mastitis, and it was established that this fact had been taught to attendants of the farmers training courses at LITI Buhuri. Results suggest that following dissemination, respondents were aware that other methods of mastitis prevention may have been more important than that of complete milking, or alternatively, project dissemination methods may have understated the importance of this fact as a method of prevention of mastitis. Recent studies on naturally occurring mastitis in smallholder dairy cattle in Tanzania (Karimuribo, 2002) showed that allowing a calf to suckle residual milk from its dam after each milking was protective against subclinical mastitis. This effect was significant when subclinical mastitis was measured at the quarter level by California mastitis test (CMT) score of >1, by positive bacteriological culture or by both, i.e. CMT>1 in combination with a positive bacteriological culture. There are a number of possible reasons for this finding including complete emptying of the mammary glands resulting in residual milk that may be infected being removed from the gland, or a possible beneficial effect of calf saliva on the commensal bacteria at the teat duct canal. Oxytocin has been shown to remove toxins from the gland and maintain teat duct patency (Anon, 1977) and it is possible that suckling acts in a similar way to this compound. In the current study, it is possible that the investigators did not give sufficient weight to residual calf sucking as a means of mastitis prevention due to their own lack of experience of this management technique. For many years, calves in the UK born to dairy cows usually only suckle for a limited number of days, or even hours, and any beneficial effect of regular calf suckling will not occur.

It is widely accepted that the productivity of the livestock sector in Tanzania is extremely low (Mdoe et al., 1998; Melewas and Rwezaula, 1998), and this is often attributed to disease challenge, poor husbandry practices and poor nutrition (Melewas and Rwezaula, 1998). It has also been stated that improved productivity of the livestock sector could facilitate alleviation of poverty for a number of people (Mdoe et al., 1998). The success of this project in disseminating knowledge to smallholder farmers may therefore help to optimise milk production, and bring about improved productivity on smallholder farms, through improved husbandry practices for udder health and milking, and by helping to prevent mastitis from occurring in smallholder dairy cows. There is, however, currently no provision for continuation of the project, and it is hoped that the knowledge dissemination achieved thus far will be sustainable in the absence of further reinforcement.

6.3 DIssemination materials

The dissemination materials developed by the project were widely accepted, and generally well understood. This suggests that their design and content was appropriate, and that the visual literacy of respondents (Linney, 1995) was sufficient to allow them to accurately understand and interpret the images presented to them. Dulle (1999) discussed the importance of providing information to non-literate respondents, a fact which is often overlooked, and it is felt that the materials produced by this study have proved to be effective, and also appropriate for a range of literacy skills. It is hoped that they may be of value to future projects, and could be used without alteration in their present state in any country where Kiswahili is the mother tongue

The success of the project handout as a dissemination material differed markedly in the two phases of the project. This was an extremely interesting finding, as the handout used in both phases was identical. It may be hypothesised that those respondents in the 'handout' group in Tanga were personally given a handout and received no other form of dissemination, whilst handout were distributed in Iringa as one of the forms of indirect dissemination. The attention given by respondents to the handout in the two areas may therefore have differed.

6.4 Farm practices

This project identified and recorded practices commonly undertaken on Tanzania smallholder farms concerning udder health and milking. Other studies have hypothesised that mastitis in smallholder dairy cattle may be due to poor husbandry practices, including irregular and incomplete manure removal from bandas, superficial washing of the udder, use of a communal towel to dry the udder of a number of cows, and poor hygiene of milkers (Njau, 1983; Machang'u and Muyungi, 1988). Results of this study have confirmed that these practices do indeed occur on a number of farms, however, their association with the incidence of mastitis has been investigated by the project PhD colleague (Karimuribo, 2002).

6.5 Major Conclusions

Major conclusions that could be drawn from the current study were:

a) Cowboys were responsible for the majority of milking and banda cleaning activities, whilst wives were responsible for the majority of supervision of these activities. For this reason, cowboys and wives potentially had the greatest influence on prevention of mastitis, and thus should be the targets for future mastitis education, where possible.

b) A number of sociological factors influenced which member of a household was permitted to attend a training activity.

c) The extent of further dissemination of mastitis knowledge by participants of the MTC was extremely variable, and was particularly poor amongst urban participants.

d) Both the short-term and long-term effectiveness of dissemination methods varied widely according to the fact.

e) The MTC, video screenings, EO and project pen were effective methods of dissemination to a community in the short-term.

f) The MTC and EO were effective methods of dissemination to a community in the long-term.

g) All methods used in the study were effective for the direct dissemination of mastitis facts to individual respondents when compared to control groups.

h) The effectiveness of direct dissemination methods varied widely according to the fact.

i) Recommendations for the most effective method of dissemination varied according to the fact.

j) The 'handout', 'village meeting and video', 'village meeting and handout', and 'village meeting, video and handout' methods of dissemination were the most effective overall methods of direct knowledge dissemination about mastitis to smallholder farmers in Tanzania. The combination methods 'village meeting and video', 'village meeting and handout' and 'village meeting, video and handout', showed no significant advantage over the 'handout' method alone.

k) Other variables that were significant in the direct dissemination of mastitis facts were the category of question type, the level of education of the respondent, methods by which the respondent has previously learned about mastitis, classification of the village, number of years owning dairy cattle, the frequency with which a respondent milked the cows, and the proportion of respondents who were aware of that mastitis fact prior to dissemination.

l) A preliminary investigation of the 'Hawthorne effect' suggested that the phenomenon was not significant, and thus, involvement in the study and administration of an open-ended questionnaire prior to dissemination had no significant effect on a respondent's subsequent mastitis knowledge.

m) The dissemination materials developed for this study were all effective methods of dissemination about mastitis to smallholder farmers. As the materials have been produced in Kiswahili, they could all be used in other East African countries without further modification. In addition, editing into other languages would be possible, and relatively simple, particularly for the project poster and diagrammatic handout, and the use of subtitles would be possible for the final edited video.

6.6 Recommendations

From results obtained in the current study, the following recommendations may be of importance concerning future knowledge dissemination to smallholder farmers in Tanzania.

a) Prior to devising a dissemination programme, the most appropriate target of the programme should be identified. Steps should then be taken to facilitate attendance of the target individuals at the training, and an appropriate and acceptable programme should then be designed.

b) In urban areas, training of key farmers may be of little use for further dissemination of information to fellow farmers. If urban farmers are the intended targets of a dissemination programme, a recommended course of action would be to advertise the programme to all farmers, with an accompanying request to elect their own representative to attend the programme. Fellow farmers could then be encouraged to apply pressure on the elected individual to further disseminate the information upon completion of the programme.

c) Farmers' perception of the importance of a recommendation appears to have an influence on it's uptake. Participatory methods should therefore be used during dissemination of information to farmers, in order that acceptable and appropriate action plans and recommendations may be formed, which may have an increased likelihood of uptake by other farmers.

d) It is suggested that only a small number of key facts (perhaps a maximum of ten points) are incorporated into a dissemination programme, rather than a wide range of facts, or recommendations.

e) It is likely that reinforcement of the majority of recommendations is necessary to maintain the level of knowledge in a population over a long-term period of time.

f) All dissemination materials should be thoroughly pre-tested with representative members of the target population prior to use. Amendments should then be made, and further pre-testing carried out, until the dissemination material is easily understood, and accurately conveys the intended messages.

g) Diagrammatic handouts, accompanied by explanation at the time of distribution, are an effective method of disseminating information about mastitis to individual smallholder farmers. Conclusions may, however, only be drawn about the methodology implemented in this study, which involved individuals being visited at their home and receiving explanation about the diagrams at the time of distribution. Whilst this method is useful under situations where budgets for dissemination materials, and access to audiovisual equipment and electricity, are limited, it does have implications for the time required, and distance travelled, to disseminate the material. A recommendation for future studies would therefore involve evaluation of the effectiveness of group distribution and explanation of such handouts, which, if successful, would provide both a cheap, and effective, method of disseminating information.

h) Village meetings, in combination with either a video screening, or a video screening plus diagrammatic handout distribution, are also effective methods of disseminating information about mastitis to smallholder farmers. These methods have financial and technical implications for use, however they are particularly useful when time is a major constraint, as they facilitate dissemination of consistent information to a large audience in a period of approximately two hours. These methods also provide a focal village event that could be used additionally as a platform to promote other topics, or projects.

i) It would be desirable to source further funding in order to facilitate production of final, professionally produced materials for use in other areas, and by other projects. Minor modification of the design of the project diagrammatic handouts, to exclude arrow symbols, would result in an easily understood dissemination material. Professional artwork and printing would enhance the appearance of the handout, which, accompanied by production in a laminated format, would result in a durable, easily understood, diagrammatic textbook with Kiswahili annotation which could be distributed to smallholder dairy farmers throughout East Africa. In a similar fashion, minor modification, and professional printing of the project poster would also result in a useful dissemination material that could also be used throughout East Africa.

j) Future projects would be advised to incorporate a generous budget for the development of dissemination materials, to allow professional design (preferably by local artists) of the materials, thorough pre-testing of materials, and production of dissemination materials in a durable format.

k) If indirect dissemination methods, involving key individuals for further dissemination of information are used, it may be advisable to incorporate a competitive element to the exercise, with a prize being awarded to the key individuals who effectively disseminate the information to the greatest number of people.