Final Technical Report

Project Number R7271

Optimising Milk Production on Smallholder Dairy Farms in Tanzania: Studies of the Epidemiology and Socio-economics of Animal Disease and the Quality and Safety of Milk

Contents

VOLUME ONE

EXECUTIVE SUMMARY

The project investigated issues relating to animal health in smallholder dairying systems in two areas of Tanzania. The emphasis in Tanga was on tick borne disease while the majority of research in Iringa concerned mastitis.

Dairy cattle crude mortality (per 100 cattle years risk) was 8.5 and 14.2 for Tanga and Iringa, respectively. Reported causes of mortality in Tanga (n=55) included 36% to ECF and 8% to anaplasmosis. Equivalent figures for Iringa (n=93) were 32% to ECF and 10% to anaplasmosis. During the longitudinal survey, 11.6% of the 549 calves monitored died with 37% of deaths diagnosed as being due to ECF and 18% due to anaplasmosis. There was geographic variation in the distribution and force of infection of the five tick-borne pathogens studied. Zero grazing animals to protect them from TBDs was found to be effective but the rate at which grazed and ungrazed animals seroconverted to *T. parva* and *A. marginale* was not significant.

Male calves were more likely to die than female calves. F2 and F3 animals had a higher mortality risk than F1 cattle. Bought- in animals were more likely to be sero-positive for *T. parva* and *B.bovis* than were home bred animals and cattle acquired under credit schemes were less likely to be seropositive for *T. parva* and *B.bovis* than animals that were purchased or obtained as gifts. Farmer training appeared to reduce the risk of mortality but not seroconversion of cattle. Training may improve ability to recognise and treat clinical cases rather than encourage reduction of contact between cattle and infected ticks. Farmer-reported variations in the frequency of use and methods of application of acaricides were not associated with variation in risk of exposure to TBDs. Results confirm the widespread misuse of acaricides by farmers.

Clinical mastitis in the cross-sectional study was found in 18.5% of cows in Iringa and 10.1% of cows in Tanga, an overall incidence of 14.2% (n=611). A higher proportion of farms in Iringa reported clinical mastitis cases (29%) compared to Tanga (17%).The prevalence of subclinical mastitis was 76% (CMT positive cows) and 44% (bacteriologically positive cows). The average incidence rate for clinical mastitis in the longitudinal survey was 0.9 cases per 100 cows in milk per month. The

incidence of subclinical mastitis was 48.6% (CMT positive quarter) and 28% (bacteriologically positive quarter).

Risk factors associated with clinical and/or subclinical mastitis included: cows of the Boran breed; bought in cows; washing the udder with a cloth; leaving one quarter unmilked; having two milkers per farm; having a soil or hard core floor to the banda. Protective factors against clinical and /or subclinical mastitis included: washing and drying the udder cloth; stripping and post milking teat dipping; allowing a calf to suck the cow; farmer experience of dairying; selling milk from the farm; having a concrete floor to the banda.

Methods of dissemination that had a positive association with mastitis knowledge one month after dissemination were the mastitis training course, video screenings, the project pen and the extension officer. Sixteen months after dissemination, only the mastitis training course and the extension officer had a positive association with mastitis knowledge. Dissemination messages were generally directed towards heads of households rather than employees or household members closely connected to cow care.

Background

Dairy farming in Tanzania has been in rapid transition over the last 20 years. Before independence, large scale dairying was carried out by settlers in the Northern and Southern Highland Zones. After independence in 1961, some of these farms were nationalised, most being operated by a parastatal organisation, the Tanzanian Dairy Farming Company. In 1983, the Ministry of Livestock Development launched a new policy promoting smallscale dairy farming. Bi-lateral development projects were started in Iringa, Mbeya, Tanga and Kagera regions while NGOs also supported the development of the smallholder dairying schemes in other regions.

In Iringa, smallholder dairying was introduced by the Tanzanian government with assistance of the Swiss through the Southern Highlands Dairy Development Project while in Tanga the Tanga Dairy Development Programme was established with the assistance of the Dutch. Both organisations have facilitated the acquisition of

crossbred dairy animals, usually through heifer-in-trust schemes, provided extension support, and assisted with business development and marketing.

Smallscale dairying worldwide is beset by numerous problems, some of which are technical, some monetary and some political. Thorpe *et al* (1993) reports that farmers on the coast of Kenya identified lack of finance and diseases and pests as critical constraints on agriculture. Tick borne diseases represent a specific threat and represent a growing concern because of the risks of mortality (Tanga Dairy Development Project, 1996). This project was intended to investigate important issues of health in smallscale dairying in Tanzania.

Project Purpose

The stated objectives of the project were:

- To identify the perception and importance of smallholder dairying within households in Tanzania
- To quantify the key determinants of health and productivity of cattle on these farms
- To devise sustainable, environmentally sound and cost-effective strategies for minimising disease and optimising health and productivity
- To assess the risk of milk-borne zoonoses and antibiotic residues on consumer health

The focus of the project was (a) tick-borne disease, and (b) mastitis. The project was carried out in two regions of Tanzania, namely Tanga in the northeast and Iringa in the Southern Highlands. The research emphasis was tick-borne disease in Tanga and mastitis in Iringa.

Chapter 3: Cross-sectional Study of Mortality in Smallholder Dairy Farming Systems

1. MATERIALS AND METHODS

1.1 Location of the study

The mortality study was conducted in the two regions of Tanzania, Iringa and Tanga, described in detail in Part 1.

1.2 Selection of study farms

The study was carried out in all the farms that participated in the cross-sectional study. The selection procedures are described in Part 3, Chapter 1.

1.3 Study design

The sample size of 200 randomly selected farms from each region was estimated to provide 80% power to detect a relative risk of 2.0 with 95% confidence and 'design effect' of 2.0 (French & Tyrer, 1997). The exposure to disease was estimated to occur in 40% of the cattle population in which 5% of unexposed cattle died. The average herd size was estimated to be 3 to 4 cattle.

1.4 Data collection

Using a structured questionnaire, farmers (or any member of the family) from all selected farms were interviewed during the period of January to April 1999. Information concerned the farm and animal events that occurred during 1998 were gathered and recorded. Farmers were asked to give details of cattle that were alive at any stage during 1998. Information collection involved detailed tracing of all animals on the farm and examination of written records. Information collection procedures continued until all the ages of the cattle, dates of birth, dates of deaths and movements on to and off the farm agreed chronologically.

2. Definition of Outcome Variable

2.1 Mortality rate and risk

Mortality rates were defined as the number of deaths from various etiological agents expressed as percentages (animal –year –risk) of the total number of dairy animals (all ages, breeds and sex) ever present in the study farms at any stage during 1998. Mortality risk or risk rate is defined as the probability of an animal experiencing the event of interest (death) during the year of study (1998).

3. Data Management and Analysis

3.1 Data entry and storage

Data recorded in the questionnaires were entered in data set files in Epi-info (version 6.04 CDC, USA). Data analysis was done using both Epi-info (version 6.04) and S-plus 2000 analytical software programme (Math Soft Inc., USA). After thorough screening, farm and animal level files were exported to S-plus 2000 (Math Soft Inc., USA) software programme. The two files were merged to form one file ready for analysis.

3.2 Mortality rates and risk estimate

Mortality rate was estimated using the following formula:

$$Mortality\,rate = \frac{Number\,of\,deaths\,during\,1998}{Animal\,days\,at\,risk}$$

Animal days at risk are the total number of days the study animals were present during the year under study. An animal's number of days present during the study was calculated as the difference between its date of exit (or end of December 1998) and its date of entry (or start of 1998).

Mortality rate was converted into mortality risk from the following formula:

$$Mortality\ risk\ (\eta) = 1 - e^{-\lambda}$$

The probability of an animal not surviving one year assumes mortality events are exponentially distributed (Martin *et al.*, 1987).

Mortality risks were estimated for various animal and farm level factors.

3.3Statistical methods

3.3.1 Statistical analysis

For mortality estimates, the farm was the primary sampling unit. The study population was all dairy stock that was alive at any time during 1998. The outcome variable was the time to death or censoring (whether the animal left the farm or reached the end of the study period). Individual animal and farm level risk factors examined for both study sites, and their categories are detailed in Table 4.1 to 4.4. Data were analysed using Epi-Info version 6.04d (CDC, Atlanta, USA), S-plus 2000 (Math soft version Inc.) and EGRET for Windows version 2.0 (Cytel Software Corporation, 1999). Association between binary outcome (presence or absence) and independent variables were investigated using Epi-Info. Association between binary independent variables was investigated using contingency 2x2 tables.

3.3.2 Survival analysis and modelling

The non-parametric method Kaplan Meier (1958) plot and semi-parametric Cox (1972) proportional hazard models were used to explore the determinants of time to death as a result of all causes. Frailty terms (Therneau, 1994) were added to the model in order to allow for possible variation attributed by farms. Multivariable models were used to explore the relationship between mortality and farm and animals-level variables. The final models were constructed by a forward stepwise procedure and the criteria for inclusion and exclusion was a change of in deviance significant at the 5% level according to the maximum likelihood ratio test- Chi square distribution.

Survival curves for Kaplan-Meir were plotted to show relationships between survival and key animal and farm level variables. Both grazing and age were considered as static variables (born 1998 *vs* not born in 1998 and grazed in 1998 *vs* not grazed in 1998) and non time dependence covariates. Including time dependent variables made no difference for the conclusions, so only static variables are reported.

4. RESULTS

4.1 Descriptive statistics

All 200 farms from Tanga and Iringa were visited and interviewed during the period of January 1999 to April 1999 (a 100% response rate). Visited and interviewed farms represented 40% and 6.6% of all farms in the sampling frames in Iringa and Tanga regions, respectively (Table 2.1a,b). Distribution of all the examined animals from the study regions by farm classification and administrative districts are shown in Tables 2.5a and Table 2.5b. Overall, 1,395 animals were examined.

4.1.1 Causes of ill health observed on farm

During the course of the study, 5 cases of ill health were observed in Tanga comprising: unthrift (3; 60%), lameness (1; 20%) and congenital deformity (1; 20%). In Iringa 41 cases of ill health were observed. The observed conditions were conjunctivitis (27%), TBDs (East Coast fever and anaplasmosis; 19%), mastitis (7%), unthrift (10%) and others (36%) mainly being abscess, injuries and congenital deformities.

4.2 Study farms dynamics

4.2.1 Movement of animals on and off study farms

Information gathered from study farms includes detailed tracing of all animals that stayed at some stage in the study farm during the year 1998. 376 animals left the study areas from both sites due to various reasons including 78 (21%) sold for slaughter, 116 (31 %) sold for breeding or paying back credit, 148 (39%) animals died and 34 (9%) left for other reasons including gifts, farmers leaving study area or

leaving farming altogether. During the same period, 532 animals entered the study area as a result of birth (405; 76%) or purchases for breeding (127; 24%). At the end of the study, data were available for 894 and 895 animals for Tanga and Iringa regions, respectively. These animals were alive at some stage during 1998. The annual mortality risks for each animal and farm level factor are summarised in Table 4.1, Table 4.2, Table 4.3 and Table 4.4. Corresponding survival curves for the factors investigated are reported in Figure 4.4a to Figure 4.4n.

Table 4.1 The mortality risk for animal level variables for 895 cattle on smallholder farms in Iringa, Tanzania

Variable	Categories	Number	**Mortality (%)**	**P value**
Sex	Female	643	12.9	
	Male	252	14.3	0.690
Source of animals	Brought in	291	8.4	
	Homebred	604	20.5	0.074
Filial generation	F1	427	14.0	
	F2	467	12.2	0.910
	F3	1	0.0	
Friesian cross	Yes	370	10.1	0.040
	No	525	15.6	
Ayrshire cross	Yes	574	14.8	0.130
	No	321	10.6	
Boran cross	Yes	712	13.1	0.840
	No	183	13.6	
Short horn zebu cross	Yes	183	12.9	0.910
	No	712	13.0	
Born 1998	Yes	234	37.5	<0.001
Born before1998	Yes	661	7.5	<0.001
ECF immunised	Yes	68	4.8	0.970
	No	827	14.3	
Method of acquisition	Bought cash	673	17.4	
of dairy cattle	Credit	112	0.00	0.910
	Others(gift)	110	8.91	

Table 4.2 The mortality risk for animal level variables for 894 cattle on smallholder farms in Tanga, Tanzania

Variable	Categories	Number	**Mortality (%)**	**P value**
Sex	Female	659	3.7	
	Male	235	19.9	<0.001
Source of animals	Brought in	261	0.0	
	Homebred	633	14.2	0.980
Filial generation	F1	287	10.2	
	F2	584	5.4	0.170
	F3	23	6.3	
Friesian cross	Yes	679	7.2	0.47
	No	215	4.6	
Ayrshire cross	Yes	215	4.7	0.320
	No	679	8.2	
Boran cross	Yes	153	8.8	0.580
	No	741	7.03	
Short horn zebu cross	Yes	702	6.9	0.390
	No	192	8.8	
Sahiwal cross	Yes	13	9.4	0.690
	No	881	7.3	
Simmental cross	Yes	9	22.0	0.340
	No	885	7.1	
Born 1998	Yes	256	20.3	<0.001
Born before1998	Yes	638	4.2	<0.001
ECF immunisation	Yes	6	0.0	<0.001
	No	888	5.0	
Method of supply	Bought cash	341	10.4	
of dairy cattle	Credit	448	5.5	0.220
	Others (gift)	105	4.8	

Table 4.3 The mortality risk for farm level variables for 894 cattle on smallholder farms in Tanga, Tanzania

Variable	Categories	Number	**Mortality (%)**	**P value**
Sex of owner	Female	96	14.9	0.082
	Male	798	6.3	
Grazing (1998)	Zero grazing	786	6.7	0.230
	Free grazing	108	12.5	
Farm classification	Peri-urban	178	6.5	
	Urban	331	8.8	0.200
	Rural	385	6.3	
Tick control	Yes	881	7.5	0.990
	No	13	0.0	
Application methods: Hand spraying	Yes	594	8.2	0.170
	No	300	4.9	
Hand dressing	Yes	49	7.8	0.920
	No	845	7.2	
Pour- on	Yes	223	4.59	0.180
	No	671	8.24	
Brush	Yes	115	5.3	0.940
	No	779	7.3	
Application frequency	< one week	511	7.90	
	> one to two week	322	7.03	0.210
	> two week	61	2.66	
Training course	Yes	556	5.2	0.053
	No	338	10.4	
AEZ	5	439	3.9	
	6	153	3.0	
	7	167	3.5	0.670
	12	130	9.5	
	14	5	0.0	
District	Korogwe	80	8.7	0.340
	Lushoto	121	8.7	0.046

	Muheza	234	3.9	0.006
	Pangani	35	34.0	0.333
	Tanga	424	6.2	

Table 4.4 The mortality risk for farm level variables for 895 cattle on smallholder farms in Iringa, Tanzania

Variable	Categories	Number	**Mortality (%)**	**P value**
Sex of owner	Female	93	21.7	0.850
	Male	802	13.3	
Grazing (1998)	Zero grazing	497	13.1	0.055
	Free grazing	398	14.0	
Farm classification	Peri-urban	178	23.8	
	Urban	505	17.1	0.970
	Rural	212	0.0	
Tick control	Yes	865	13.6	0.230
	No	30	4.2	
Application methods: Hand spraying	Yes	806	13.3	0.940
	No	89	13.3	
Hand dressing	Yes	177	13.1	0.940
	No	718	13.2	
Pour -on	Yes	143	11.6	0.540
	No	752	13.6	
Brush	Yes	144	15.6	0.580
	No	751	12.8	
Application frequency	< one week	791	13.7	
	> one to two week	74	12.4	0.180
	> two week	30	6.1	

Training course	Yes	361	5.7	<0.001
	No	534	17.3	
Districts	Iringa Urban	640	20.9	0.960
	Iringa Rural	255	4.6	

4.3 Mortality estimates

4.3.1 Mortality response from study farms

Of the 1771 dairy cattle from both regions that were reported to have been alive at some stage in 1998, 148 were reported to have died between January and December 1998 including four stillbirths. Of these, 58 (39%) were males and 90(61%) were females. Of the recorded deaths, 93(62%) were reported from Iringa and 55(36%) from Tanga respectively.

The overall estimated mortality rates by administrative region and district are shown in Table 4.5. Pangani district in Tanga and Iringa urban in Iringa Region were associated with high mortality rates compared to other districts.

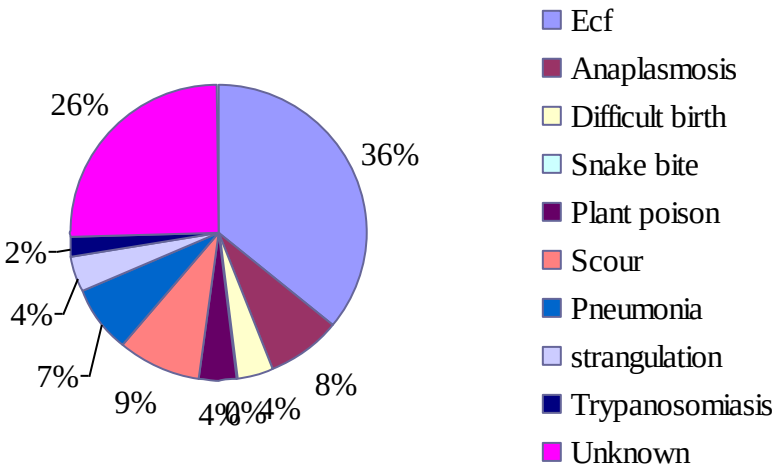
Table 4.5 Estimated dairy cattle crude mortalities (per 100 cattle years risk) from the two study sites –Iringa and Tanga Regions in 1998.

Region	District	Mortality rate	(SE)
Tanga	Tanga	6.4	1.4
	Korogwe	9.2	3.0
	Muheza	4.4	1.4
	Pangani	41.6	13.0
	Lushoto	9.2	3.2
	Overall	8.5	1.0
Iringa	Iringa Urban	23.5	2.4
	Iringa Rural	4.7	1.0
	Overall	14.2	1.4

The major cause and monthly pattern of deaths are shown in Figure 4.1 and Figure 4.2. Monthly ECF mortality rates pattern for both Tanga and Iringa is reported in Figure 4.3. Tick borne diseases, specifically ECF, was reported to be the major cause of deaths. Deaths were reported to occur in all months of 1998. Death due to ECF was reported to occur in all months of the year except for January. Though not statistically significant, peak ECF mortality rates seemed to occur between August to December.

Fig 4.1 Reported causes of mortality from surveyed farms in Iringa and Tanga during the cross-sectional study, January –April 1999

(a) Reported causes of mortality in Tanga (N = 55)



(b) Reported causes of mortality in Iringa (N = 93)

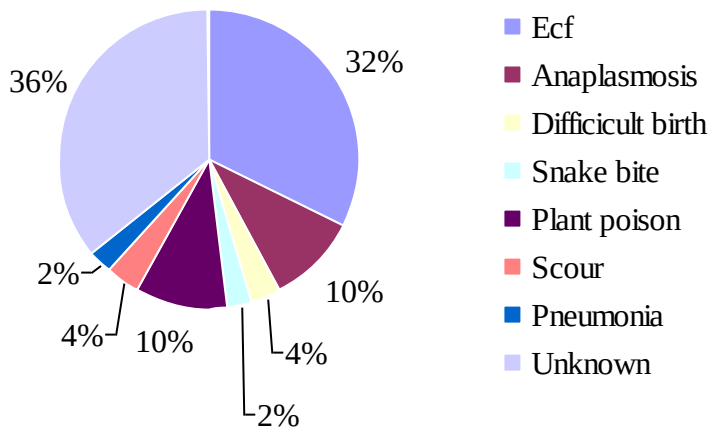


Fig 4.2 The estimated (all causes) mortality rates by month of year (1998) for cattle on smallholder dairy farms in Iringa and Tanga, Tanzania. The error bars are standard errors assuming a Poisson error distribution and finite population correction.

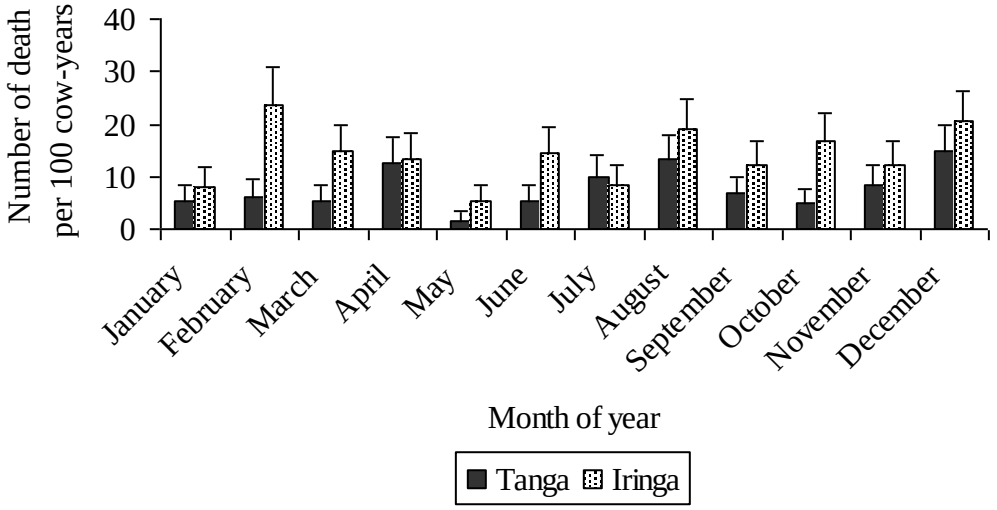


Fig 4.3 The estimated ECF mortality rates by month of year (1998) for cattle on smallholder dairy farms in Iringa and Tanga, Tanzania. The error bars are standard errors assuming a Poisson error distribution and finite population correction.