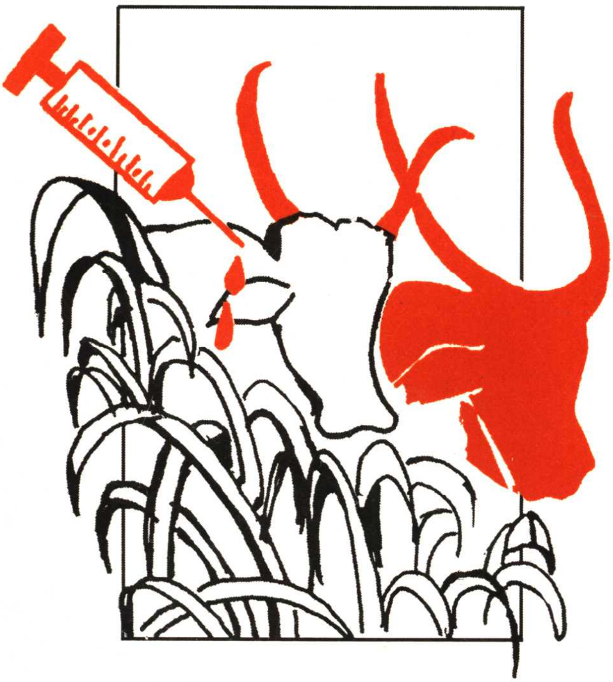
ILRI

Smallholder Dairy Technology in Coastal Kenya

An adoption and impact study



December 1999

International Livestock Research Institute

ILRI Impact Assessment Series

Smallholder Dairy Technology in Coastal Kenya

An adoption and impact study

ILRI Impact Assessment Series 5

C.F. Nicholson, P.K. Thornton, L. Mohammed, R.W. Muinga, D.M. Mwamachi, E.H. Elbasha, S.J. Staal and W. Thorpe

International Livestock Research Institute
P.O. Box 30709, Nairobi, Kenya

Acknowledgements

This collaborative study was carried out by the Kenya Agricultural Research Institute (KARI), the Kenyan Ministry of Agriculture (MoA) and the International Livestock Research Institute (ILRI) between February 1997 and June 1998. We are very grateful to our colleagues in these organisations who gave us help and advice. We are also very grateful to the Director, KARI, for his support to the study. The work was partially funded by the Impact Assessment and Evaluation Group (IAEG) of the Consultative Group on International Agricultural Research (CGIAR). We thank the following for their valuable input:

G. Wainaina, Provincial Animal Production Officer, MoA, Mombasa
C.D. Mwatate, Provincial Dairy Officer, MoA, Mombasa
P.M. Bakari, District Dairy Officer, MoA, Kilifi
G.M. Wambua, District Dairy Officer, MoA, Kwale

and the following Ministry of Agriculture enumerators:

J. Mukono, Matuga Division, Kwale District
B. Mwabushuti, Kubo Division, Kwale District
R. Juma and C.M. Ngeka, Msambweni Division, Kwale District
K. Mwatsuma and J. Mativo, Malindi Division, Malindi District
S.P. Baya and J.M. Tsuma, Kaloleni Division, Kilifi District
P.C. Madenje, Bahari South Division, Kilifi District
S.K. Mwachiro, Bahari North Division, Kilifi District

and the following enumerators from the Ministry of Health (MoH) and the Central Bureau of Statistics (CBS):

M. Locho, C. Iminzah, P. Mwanyika, D. Amunga and D. Mwachiro, MoH, Kwale District
R. Wasike, MoH, Kilifi District
J. Otiato, L. Chea and R. Mwasaha, CBS, Kilifi District
J. Odongo, C. Ziroh, E. Galgalo and S. Kadilo, MoH, Malindi District
N. Konde, F. Ruwa and R. Mkuzi, CBS, Malindi District.

We thank Patti Kristjanson and Tom Randolph for comments on a previous draft of the report, and Andrew Odero, Russ Kruska and Mohammed Salim Baya, ILRI, for help with data entry, data analysis and map-making.

Table of Contents

List of Tables

List of Figures

Abstract

This study examined the factors influencing adoption of three related dairy technologies in coastal Kenya, and assessed the impacts of dairy adoption on household income, employment generation and nutritional status of pre-school children. The technologies studied were adoption of grade and crossbred dairy animals, planting of the fodder Napier grass and use of the infection and treatment method of immunisation against East Coast fever. A series of household surveys was conducted from mid-1997 to mid-1998. The descriptive results from surveys of 202 households in Coast Province indicate that adoption of a grade or crossbred dairy animal may result in substantial increases in household income, can generate paid (secondary) employment, and may improve the nutritional status of pre-school-age children in the household. Econometric analyses, which controlled for numerous confounding factors, provided less consistent support for the impact of adoption on household income and paid employment. It appears that neither the adoption nor productivity of dairying are constrained by poor availability of technology options. For dairy development activities on the coast, two areas merit attention: mechanisms for easing access to grade and crossbred dairy cattle, either through credit schemes or through self-help smallholder co-operatives, and reducing the disease risks associated with grade and crossbred dairy animals.

1 Introduction

In many parts of Africa, smallholder farmers are being compelled by policy and markets to diversify their traditional export crops, whose potential for growth remains uncertain. Alternative agricultural activities are needed which offer higher returns to land and labour, offer the expectation of future growth, and which are suitable for adoption by the resource-poor smallholder farmers who continue to dominate African production. Market-oriented dairy production may fill this need for some smallholder producers.

The reasons for promoting dairy research have fundamentally to do with improving the opportunities and welfare of smallholder farmers and the consequent effects on agricultural development. The avenues of this impact are several:

1. There is good potential for increased demand and higher real prices for dairy products.
2. Dairying can lead to increased levels and stability of income generation for producers.
3. Dairying can increase employment in rural areas both directly and indirectly through supply of inputs and locally produced household items, and through increases in rural capital accumulation.

Other impacts may be either positive or negative, including the impact on women in the household in terms of income generation and access, and labour demands and allocation. Similarly, the impacts of intensive dairy development on the poorest households may be indeterminate. Finally, dairying can have positive impacts on soil fertility maintenance in intensive mixed cropping systems, a role that may grow with intensification.

Various previous studies have examined the adoption of dairy technologies and their impacts on smallholders in Kenya (some of these are summarised in Appendix 1). The objectives and focal points of these studies are diverse. Previous adoption-oriented research has examined the use and diffusion of dairy-related technologies (Metz 1993; Metz et al 1995) and the factors affecting adoption of Napier grass on smallholder farms (Irungu et al 1998). Impact-oriented studies have examined changes in the roles of women in livestock production and marketing (Price Waterhouse 1990; Mugo 1994; Mullins et al 1996), and how dairying affects the nutritional status of households (Launonon et al 1985; Leegwater et al 1991; Huss-Ashmore 1992). Many of these studies were motivated, at least in part, by the efforts of the National Dairy Development Project (NDDP), which was active in 24 districts in Kenya at the time of its completion in 1995.

Previous technology adoption and diffusion studies emphasise the high variation in adoption rates and factors apparently influencing the adoption of dairy-related technologies and practices. The impacts of dairy adoption, like the prevalence of adoption itself, vary by location in Kenya. These studies provide useful if inconclusive evidence that households benefit in certain ways from the adoption of smallholder dairy production and marketing. A number of important issues remain unresolved, however. These include:

- Is off-farm income a prerequisite for adoption of dairying, and by how much does dairy increase total household incomes?
- How much, if any, paid (secondary) employment does the adoption of dairy generate?

- To what extent does dairying itself improve nutritional outcomes for pre-school age children?

This study attempts to address these issues through the application of quantitative methods that use samples of households with and without dairy production and allow for controlling of multiple confounding factors (von Braun et al 1989; Randolph 1992). The study constituted one of the case studies carried out under the auspices of the Impact Assessment and Evaluation Group (IAEG) of the Consultative Group on International Agricultural Research (CGIAR), as part of the project 'Assessment of the adoption of CGIAR agricultural innovations'. This study set out to identify the factors that lead farmers to adopt or not adopt agricultural innovations, through a synthesis of nine case studies. The IAEG project was designed to help produce persuasive and conclusive information to CGIAR donors, and formulate recommendations for improving the rate and extent of adoption of innovations.

The objectives of this study were therefore:

- to examine the factors influencing adoption of three related dairy technologies in coastal Kenya
- to assess the impacts of dairy adoption on household income, employment generation, and nutritional status of pre-school children.

Research results from studying the adoption and impact of dairy technologies in coastal Kenya can be expected to inform ongoing KARI and ILRI research on smallholder dairying in other parts of Kenya. The results will also benefit other ILRI dairy-related research being carried out with national partners in Ethiopia, Tanzania, Uganda, West Africa and elsewhere in the tropics. More generally, the results and conclusions will be relevant for informing policy makers and development agencies interested in supporting smallholder dairy production in difficult and risky production environments.

2 KARI–ILRI collaborative research and development support to smallholder dairy in coastal Kenya

Coast Province, Kenya, and the environment for smallholder dairying

Coast Province covers over 80,000 km^2 in the south-eastern part of Kenya, constituting about 15% of the country's land area. Most of the province's population resides within 100 km of the Indian Ocean, although large areas of the province are up to 400 km from the coast (Figure 1). The population is estimated at over 2 million inhabitants, or about 7% of Kenya's total population of 28.8 million (1997 estimate). Coast Province is home to a large number of ethnic groups; an estimated two-thirds of the population are members of related ethnic groups referred to collectively as the Mijikenda. The Mijikenda have a history in the area stretching back at least two centuries (Waaijenberg 1994). The other one-third of the province's inhabitants are migrants from Kenya's highlands. These migrants are primarily from the Machakos area of Eastern Province, the densely populated areas of western Kenya, and from central Kenya. These migrants generally have a stronger tradition of dairy cattle keeping than the Mijikenda. Increasingly, the population of the province lives in urban areas; at present about 45% live in Mombasa and other urban centres.

The economic development of Coast Province has lagged behind other areas of Kenya (Leegwater et al 1991). The province suffers from 20% higher infant mortality than other parts of the country. Malnutrition of children is common—nearly 40% of the children are stunted to some degree—and the prevalence of rural poverty may be more than 40% of all households. The percentage of girls enrolled in primary education is only two-thirds that of the rest of the country (Greer and Thorbecke 1986; Foeken et al 1989). As a result, living conditions in large parts of the province have been described as 'harsh' (Leegwater et al 1991).

The climate of the region varies with distance from the coast and the border with Tanzania. The climate becomes drier moving inland from the ocean and from south to north. The most commonly used classification scheme defines the region's agro-ecozones based on mean annual rainfall, temperature and soil type (Jaetzold and Schmidt 1983). Much of the province is classified as coastal lowland (CL) zones. The CL zones (Figure 1) are subdivided into the Coconut-Cassava zone (CL3), Coconut–Cashew zone (CL4), and Livestock–Millet zone (CL5). Annual rainfall is highest in CL3 (1000 mm per year), lower in CL4 (900 mm per year), and lowest in CL5 (700 to 900 mm per year). Rainfall in the entire area is bi-modal, with the long rains beginning around April and the short rains beginning in October. Mean annual temperature ranges from 24°C to 27°C, but maximum temperature averages over 30°C during the hottest months, January to April.

Most rural households in the region engage in diverse agricultural and non-agricultural activities. Maize, cassava and cowpea are the staple foods grown in the area, although it is

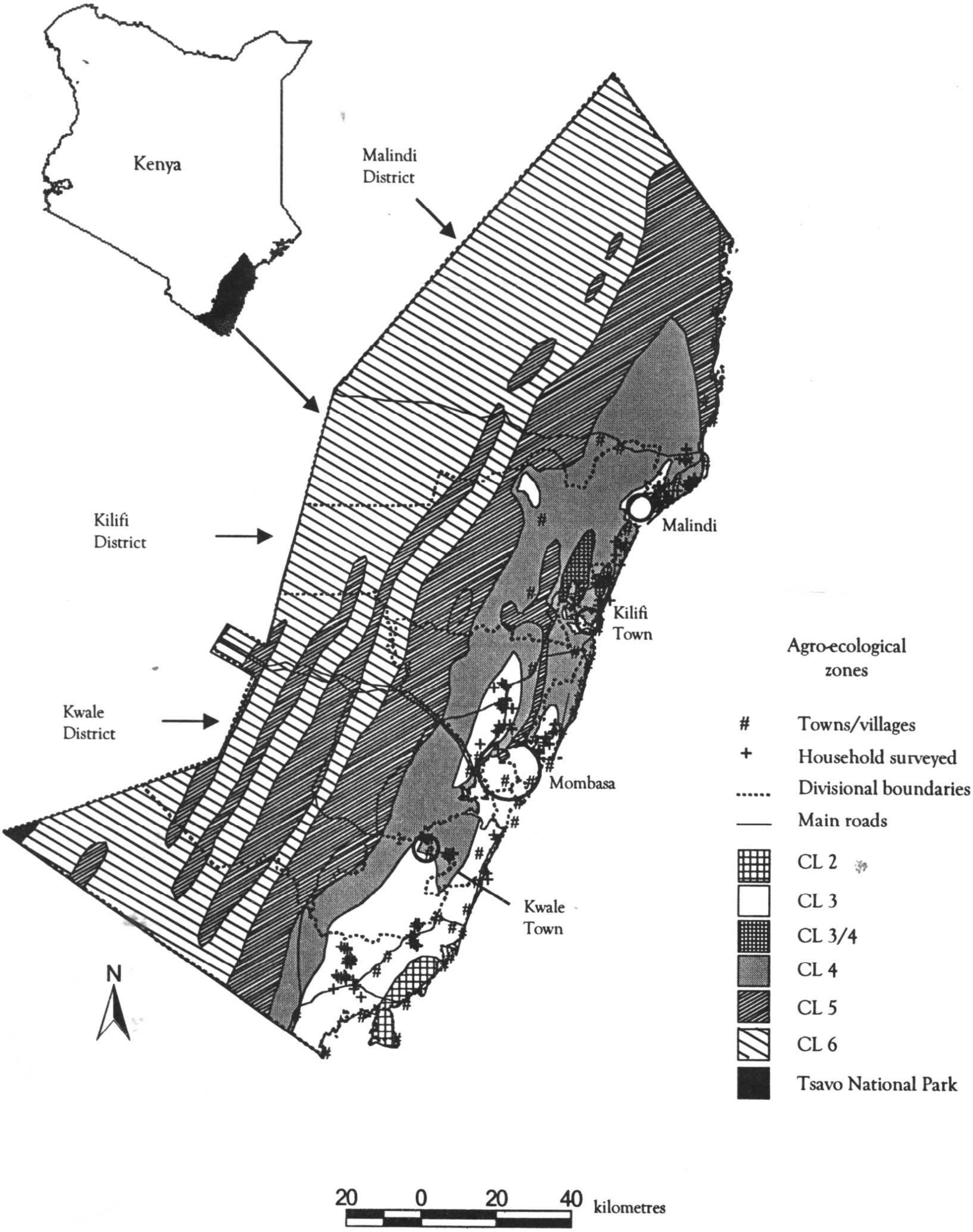


Figure 1. *Study region for the adoption and impact study.*

estimated that own-production accounts for less than half of the amount of these staples consumed by the majority of households (Leegwater et al 1991). The region is thus a food deficit area that imports staple foods from other parts of the country. Coconut palms and cashew trees provide important sources of cash income for many rural households; oranges and mangoes are widely produced and sold, and bixa is a common cash crop in Kwale District. In the CL zones, cattle are owned by about 20% of rural households (Thorpe et al 1993), whereas ownership of goats and sheep is more common. Most households also raise poultry for home consumption.

Employment off farm has become an important source of income for rural households, in part because of the development of the tourism industry in coastal Kenya. Most studies report that about two-thirds of rural households have income from non-farm activities. Leegwater et al (1991) reported that one-quarter of all adults in rural households worked off farm; women were less likely to work off farm than men were. In Kilifi and Kwale districts, income from off-farm employment represented 60% of household income in the late 1980s (Foeken et al 1989; Hoorweg et al 1990). In addition to wages and salaries, some rural households operate small businesses such as water and tea kiosks. This importance of non-farm activities results from the low-to-moderate potential of the region for intensification of agriculture, and the need to diversify household activities to reduce risk. Waaijenberg (1994) asserts that the adoption of productivity-enhancing technologies is low due to the lack of emphasis placed by many households on agricultural activities.

Peeler and Omore (1997) estimated that Coast Province produced about 3% of Kenya's total milk supply in 1993. The coast is a milk deficit area; as much as 45% of the region's dairy consumption is supplied by other parts of Kenya. In the early 1990s many of these 'imports' were in the form of milk powder reconstituted in local processing facilities. In recent years shipments of pasteurised milk to the region have increased as the number of private dairy processors in Kenya has grown. The amount of milk brought to the province from elsewhere in Kenya during a year is equivalent to the production of about 20,000 smallholder dairy farms. Since reform of the country's dairy policy in 1992, milk prices at the coast have increased relative to those in other parts of Kenya; farm-level milk prices in the area are twice those paid in Kenya's highlands (Thorpe et al 1993). Milk and milk products enjoy a strong demand. Consumer surveys indicate that fresh ('raw') milk is preferred over packaged pasteurised and UHT (long-life) milk (Staal and Mullins 1996). The strong demand for milk and higher farm-level prices have been taken as indicators of the potential for dairy development in the region.

Although a few large and successful dairy farms have been established in the area, most of the milk production occurs on smallholder farms. The majority of milk is produced by local zebu-type cattle; based on data from this study, only about 1% of households with cattle in the area own grade or crossbred (G/C) animals. Peeler and Omore (1997) estimated that G/C animals owned by smallholders accounted for less than 4% of all cattle in Coast Province. Growth in milk production by smallholders has lagged behind demand mostly due to technical constraints. Grade and crossbred animals are more susceptible to diseases common at the coast, such as the tick-borne East Coast fever (theileriosis), anaplasmosis and babesiosis. Theileriosis is responsible for about 60% of all clinical cases, and an annual mortality rate of about 30% (Maloo et al 1994). Trypanosomosis, carried by the tsetse fly, is another important health problem for smallholders, particularly in Kwale District. In addition, seasonal shortages of feed for higher-producing dairy cows have been identified as a major constraint to milk production. The development of formal (commercial) milk marketing is limited in some areas, despite the strong local demand for milk.(Thorpe et al 1993).

The contribution of grade and crossbred cattle to production of milk by smallholders is somewhat difficult to assess based on available information. The number of adopters in the three coast districts where the KARI–ILRI work was conducted (Kwale, Kilifi and Malindi districts) is small; about 750 households of an estimated 127,000 total households own grade or crossbred animals. Some of the owners of these animals reside in urban areas and maintain rural farms with 5–10 dairy cattle as small-scale commercial operations (KARI–ILRI Impact Survey preliminary results 1998). These dairy operators are thus not typical rural smallholders. The total number of grade and crossbred cattle on smallholder farms in these three districts is estimated to be between 5000 (KARI–ILRI Adoption Survey results 1997) and 21,000 (Peeler and Omore 1997). Although small in numbers, grade and crossbred cattle are estimated to provide between 20% and 40% of smallholder milk production in the three districts. Smallholders with G/C cattle may provide up to 30% of total milk production in Kwale, Kilifi and Malindi (Peeler and Omore 1997).

KARI–ILRI collaborative research and development support for smallholder dairy

In response to a need identified by the then Ministry of Livestock Development (MoLD) in 1988, the Kenya Agricultural Research Institute (KARI) and the International Livestock Centre for Africa (ILCA, now the International Livestock Research Institute (ILRI)) established a programme to identify and resolve biological, social and economic constraints to the development, adoption and productivity of smallholder dairy systems in the coastal lowlands. The programme was based at KARI's Regional Research Centre (RRC), Mtwapa in Kilifi District.

The programme, which took a production-to-consumption systems approach (Rey et al 1993), was planned and carried out in close collaboration with MoLD's extension service through its National Dairy Development Project (NDDP) (Maarse et al 1990), and with the participation of other research institutions. The integrated programme of on-farm and on-station research covered farming systems description and constraint identification and technology development and testing. The major research areas were studies of dairy consumption and marketing, smallholder resource management, disease risk to dairy cattle, feeding systems development and dairy cattle breeding.

The results of this work confirmed the following:

- the large milk deficit (Mullins 1995)
- there were seasonal feed shortages and inadequate nutrient concentrations in diets for milk production (Reynolds et al 1993), constraints which were addressed through the development of improved feeding systems based on intercropping fodder grasses and

shrub and herbaceous legumes and the use of maize by-products (Muinga et al 1995; Mureithi et al 1995b)

- East Coast fever (ECF) was shown to cause major losses in smallholder dairy cattle (Maloo et al 1994), losses that could be substantially reduced by immunisation through infection and treatment (Nyangito et al 1994; Mukhebi et al 1995)
- rotational cross-breeding was identified as an efficient breeding system for smallholder milk production (Mackinnon et al 1996).

Collaboration with the NDDP ensured strong research–extension–farmer linkages resulting in, for example, farmer-managed forage trials. Proven on-station technologies (improved germplasm and agronomic practices) for the legumes *Leucaena leucocephala* and *Clitoria ternatea* (Mureithi et al 1995b), were tested systematically with smallholder farmers through a sequence of steps:

- farmer/extension staff visits to the long-term on-station experiments
- research–extension-managed demonstration plots on selected farms
- field days held on these farms and on those of early adopters
- farmer-managed trials on some 300 farms in four districts of Coast Province.

The studies of smallholder farming systems and resource levels (Thorpe et al 1993; Mureithi et al 1995a) indicated that for the majority of households, agricultural change will be a sequential intensification through the adoption of individual technological components rather than through the adoption of a multi-component package, such as the NDDP's zero-grazing package. Current research and extension therefore aims to provide a range of technological options adaptable to individual circumstances (Thorpe 1996).

Underpinning the technical achievements was the effective interaction established between researchers, extension staff and farmers from the beginning of the project. The orientation of the research towards field-based problems and studies and the continuous contact with farmers built up confidence between the three groups and ensured effective and productive working relationships. Contributing to this process were monthly seminars and regular workshops for presenting research proposals and reviewing results from the field studies and the experimental programme.

Subsequently these planning and review processes were institutionalised. In 1991, it was agreed that KARI's Regional Research Centre would host quarterly 'cluster' meetings of research and senior extension staff and other invited participants to review programme activities and to consider new proposals. Initially these meetings were held at the RRC but after 1992 they rotated between Kilifi, Taita/Taveta and Lamu districts. In turn, these quarterly planning and review meetings nominated research–extension working groups to organise specific interventions. For example, a working group developed the protocol for and supervised the implementation of the farmer-managed forage trials referred to above. The success of this 'cluster' mechanism for strengthening research–extension–user linkages was such that KARI and the Ministry of Agriculture, Livestock Development and Marketing (with funding from the Netherlands) replicated it nationally through KARI's regionally mandated Research Centres (Thorpe 1996).

In terms of impact, the development and transfer of appropriate technologies to address the productivity losses resulting from inadequate year-round feed resources and ECF have had a significant effect, particularly in the smallholder sector:

- over 95% of participating farmers subsequently surveyed had recommended the legumes to their neighbours
- approximately 60% of participating farmers adopted the recommended agronomic and feeding practices (Njunie et al 1994)
- application of ECF immunisation in the Kaloleni study area was estimated to have reduced mortality and increased calving rates resulting in an 8.6% annual internal growth of the dairy herd (Mukhebi et al 1995).

These results were expected to stimulate a demand from smallholders for technologies such as immunisation of dairy cattle (the infection and treatment immunisation process is a major output from KARI's National Agricultural Research Laboratories). In this case private veterinarians in the region have been trained as a step towards the sustainable delivery of the immunisation technology. Extension of the technology to smallholder dairy cattle in the high rainfall coastal lowlands may ultimately have a significant impact on the current milk deficit, if institutional problems in service delivery can be overcome.

The KARI-ILRI inter-disciplinary, inter-institutional programme contributed considerably to the development of strong linkages between the research institutions, the extension services and their clients, current and potential smallholder dairy farmers in coastal Kenya. It ensured a more effective development, testing and transfer of appropriate technologies such as improved feeding systems and ECF immunisation. The programme increased the awareness of research and development officials of the importance of effective input and output markets for smallholder dairy development. It has served as a model for the strengthening of research-extension-farmer linkages for smallholder dairy development and related agricultural development in the high potential regions of Kenya. Various important lessons were learnt from the coast programme, including the need for:

- active participation of all major stakeholders and key players in the identification and resolution of the technical, socio-economic and policy constraints along the dairy production-to-consumption chain
- effective linkages with MoALDM and related ministries at policy as well as operational level
- effective linkages with the private sector for the provision of output and input services
- effective means to implement proposals by feeding directly into the design of pilot initiatives.

3 Adoption and impact surveys of smallholder dairying in coastal Kenya

Numerous dairy-related technologies and practices could be considered in a study of adoption. Previous studies have examined the use of 20 technologies and practices associated with smallholder dairying in six districts of Kenya (Metz et al 1995), but not the factors associated with their adoption. This study focuses on a smaller number of related adoption decisions faced by smallholder farmers in coastal Kenya. The ownership of grade or crossbred animals is a key element in the development of intensive dairy production. Grade and crossbred (G/C) dairy cows have higher potential for milk production when adequately fed, and yet are more susceptible to diseases (e.g. ECF and trypanosomosis) common in many areas of Coast Province (Maloo et al 1994). Grade and crossbred cows require more feed than local cows to produce milk up to their potential. Because seasonal feed shortages have been identified as constraining milk production, the development of improved feeding systems has been a focal point for previous research (Reynolds et al 1993).

Work started in early 1997 on planning the adoption and impact study. The objective of the study was to determine the factors that influence partial or complete adoption of dairy technology. The technology was defined as ownership of a crossbred or grade dairy animal, the planting of the forage Napier grass, and the use of the infection and treatment method of immunisation against ECF. Questions as to whether adopters of this technology later 'de-adopted' or substantially modified their practices after the initial adoption decision was made, were felt to be particularly important in Coast Province. In addition, the adoption survey was to deal with three complementary technologies: crossbred dairy cows, Napier grass and ECF vaccination. There are clear interdependences between the decisions to adopt the three technologies. This is complicated somewhat by the possibility of lags (and sequencing) of adoption. For example, in some cases the decision to adopt Napier grass may be conditional on the decision to adopt cows, but the decision to adopt cows may not be conditional on the decision to adopt Napier grass, if the forage was planted a number of years after the crossbred cows arrived. Alternatively, to the extent that a package of technologies was required by the NDDP, the interdependence of adoption decisions may be mostly due to programme requirements. A series of surveys was designed to address these and other issues.

Studies of the factors influencing adoption of agricultural technologies often focus on household resource endowments, characteristics of the household head, location of the household, the nature and extent of information provided before adoption, and the characteristics of the technology (Feder et al 1985). In coastal Kenya non-farm jobs and businesses are key alternatives to intensification of agriculture for farm households (Waaijenberg 1994), but may also provide income needed for investment in more intensive dairying. Accordingly, the surveys were required to collect information on location, characteristics of the household head and sources of information used by the household head to make decisions about the choice of agricultural technologies. The surveys also included information about the characteristics of the household, perceptions about the availability of the G/C animals, availability of seeds and planting materials for Napier grass, and access to ECF immunisation. Households were also asked about their perceptions of the accessibility of the inputs and services associated with the three technologies. This information was then to be used to develop econometric models of adoption and impact (Nicholson et al 1999).

The first task was to compile a complete inventory of all households with small- or medium-scale farmers with dairy cows for the project area. The project area (Figure 1) encompassed agro-ecologies CL3 and CL4 in Kilifi District (Bahari, Kaloleni and southern Malindi divisions) and Kwale District (Kubo, Matuga and Msambweni divisions). In 1998, the boundaries of Kilifi District were adjusted to accommodate a new district, Malindi, and Malindi Division of the old Kilifi District became part of this new district. The areas south and north of Mombasa afford a substantial contrast in conditions, notably differences in trypanosomosis challenge and infrastructural development. Ministry of Agriculture staff completed the inventory, essentially a census of dairy households, early in 1997. Three separate surveys of farm households were conducted during 1997 and 1998, based on the inventory of 750 households with dairy cows in the three districts.

Adoption Survey

For the 'Adoption Survey' in June and July 1997, 75 dairy adopters and 125 non-adopters were surveyed in the three districts. The adopters, defined as households owning at least one grade or crossbred (G/C) dairy animal, were randomly selected from the inventory of all adopting households. The sample of adopters was stratified by division, the administrative unit below the district level. The total number of farmers interviewed from each division was proportional to the number of households in that location (Table 1). Non-adopting households were selected randomly from lists of 20 neighbours of adopting households.

Table 1. *Households, adopters and number of survey respondents by division.*

District	Division	Households[1]	Number of adopters	Adopters surveyed	Non-adopters surveyed	Total surveyed
Kwale	Matuga	11,010	53	6	12	18
	Kubo	6,434	20	2	8	10
	Msambweni	30,272	73	8	40	48
Kilifi	Malindi	30,243	184	19	28	47
	Kaloleni	26,167	115	12	29	41
	Bahari	23,250				
	Bahari South		89	9	4	13
	Bahari North		185	19	4	23
Total		127,376	719	75	125	200

1. Source: CBS (1994).

Impact Survey

The 'Impact Survey' administered during February to April 1998 followed the same sampling procedure; some 200 households not contacted during the adoption survey were