Factors Influencing Adoption of Dairy Technologies in Coast Province, Kenya.

Mwatsuma Kitti Mwamuye
Corresponding author
PhD Student
Jomo Kenyatta University of Agriculture and Technology
School Of Human Resource Development
P.O Box 62000-00200, Nairobi, Kenya
Phone: +254-713884625
E- mail: kapangakiti@yahoo.com

Johnbosco Kisimbii
Lecturer
University of Nairobi
Department of Extramural Studies
P.o Box 83732-80100 Mombasa, Kenya
Phone: +254-0722784108
E- mail: kisimbii@yahoo.com

DR Moses Otieno
Lecturer
University of Nairobi
Department of Extramural Studies
P.O Box 83732-80100 Mombasa, Kenya
Phone: +254-O721246929
E- mail: mosotieno@yahoo.com

Abstract

The study sought to determine the factors influencing the adoption of dairy technologies among the Mijikenda community of coastal Kenya which has variously been reported to be the poorest adopter of dairy technologies in the Coast province of Kenya. The dairy technologies under study were zero grazing as a feeding system, Napier grass establishment, silage making and hay baling which are critical in any intensive dairy

production system, the inevitable trend due to increasing population pressure worldwide. Market and Labor availability were assessed and how they influenced the adoption of the technologies.

A cross sectional survey was conducted in three districts of Coast province notably Kilifi, Kwale and Malindi since they were home to the main Mijikenda sub tribes. They also had medium dairy potential, had also implemented a dairy production program before and were implementing a project which advocated for the technologies under study. A questionnaire was administered through interview schedules to a sample of 70 farmers from across the three districts, including farmers supported by Heifer International Kenya and self financed dairy farmers.

Findings indicated no relationship between labor and market availability and adoption of the four technologies. The critical challenge to adoption of zero grazing was inadequate labor. Napier grass establishment was mainly constrained by inadequate and unreliable rainfall. Silage making was challenged by inadequate fodder for ensiling while hay baling was constrained by inadequate technical knowhow by the farmers. Technical staffs charged with the responsibilities of extension service delivery in the province were not competent with various silage making and hay baling techniques.

The study therefore recommended for a re-training of the extension service providers so as to be able to disseminate relevant technologies to the farmers. There was also need for an evaluation of the various technologies against the various agro ecological zones, farming systems and farmers resource base for enhanced technology adoption.

Key word: *Technology, Adoption Market availability Labor availability, Zero grazing*

List of abbreviations and acronyms

DLP: Director of Livestock Production

DLPO: District Livestock Production Officer

FAO: Food and Agriculture Organization

GDP: Gross Domestic Project

HIK: Heifer International Kenya

KCC: Kenya Cooperative Creameries.

KDB: Kenya Dairy Board

KARI: Kenya Agricultural Research Institute

NAEP: National Agriculture Extension Policy.

NDDP: National Dairy Development Project.

PDA: Provincial Director of Agriculture.

PDLP: Provincial Director of Livestock Production

SPSS: Statistical Package for Social Scientists.

SRA: Strategy for Revitalizing Agriculture.

1. Introduction

Smallholder dairy farming has remained an important source of livelihood in most developing countries, however the main challenge has remained poor quality and quantity of feeds leading to low milk productivity. Dairy has also continued providing a regular source of income and spreading income risk since agriculture related income was always seasonal. (Osuji1974). Challenges of dairy cattle feeding if

addressed could thus guarantee a sustainable livelihood to smallholder dairy farmers in many parts of the world..

Hemme et al. (2004) for example observed that India, despite emerging the leading milk producing country of the world in 2001, recorded a 5% decline in production of the cross bred dairy cattle. Patel, (2001) attributed India's low milk production levels to low genetic potential for milk production, poor nutrition and poor management and care of the dairy cattle.

In China, despite smallholder dairy production accounting for 76.8% of total dairy cattle production, poor knowledge of advanced dairy science and technology, insufficient supply of green forage and unreasonable diet formulation always led to low milk productivity. (Liu J.X et al 2002)

Similarly in Vietnam (Vu, D.D and Cai, D.V. 2001) observed poor feeding system resulting to poor body condition, short lactation periods, low reproductive performances, early culling and eventually low economic output as the most important constraint for smallholder dairy farmers.

Njwe et al (1984) realized that in Cameroon feed scarcity during the dry season was an important constraint to adequate feeding of animals and often resulted in lower milk yields and lower income. Under labor-intensive stall-feeding system where most of the labor burden was particularly heavy during school time and the dry season the running costs became unbearable for smallholder farmers.

Ethiopia on the other hand despite favorable environmental conditions for dairy production also identified inadequate supply of quality feed and therefore low productivity of cattle resulting in low milk yields as major factors limiting dairy production. (Redda, T 2001)

North America however, recorded over 5000 Kilograms of milk per cow per annum in the year 2010 attributable to enhanced management and proper feeding. One New Zealand cow thus produced as much as five dairy cows in India. Therefore despite a lower dairy cattle population, compared to that of Africa and Asia the steady increase in productivity per cow has led to the steady growth of the dairy industry and economy of America (FAO 2010)

A steady increase of dairy cattle population in Africa and India therefore has not been reflected in the economic growth in the dairy industry as production per cow continued to decline to about 500 kilograms of Milk per cow per annum.(.FAO, 2010).

In Kenya the Dairy industry accounted for 4.1% of Gross Domestic Product with Small holder dairy production accounting for over 70% of the total milk production and has always received a lot of attention from the government since independence (National Livestock Policy 2008)

The National Dairy development Project (NDDP) supported by the Dutch and Kenyan government was started in 1980 in six districts among them Kilifi district which included the current Malindi district of Coast province and expanded to twenty seven districts in the entire country when it was closing down in December 1994 (Maarse 1995). The project advocated and emphasized on zero grazing and the growing of at least one acre of Napier grass *(Pennisetum purpureum*) per cow as the primary forage source. Mukolwe et al (1990) however noted that about 44% of the original farmers maintained the Napier grass stands by the year 1990 and inadequate management, inputs availability, labor and milk market identified as the key factors which influenced the adoption of the dairy technologies. The project then recommended integration of research, extension and training for any sustainable intensive dairy production. However despite efforts by the government on strengthening research extension linkages very little had been realized.

The coast province of Kenya, despite the attention from the NDDP and other development agencies had over the years continued registering low growth in both the dairy cattle population and milk production. District Livestock Production Officer's Coast province (1998 to 2008) showed that, between the period 1998 and 2008 the dairy cattle population had grown by 4.4% while milk production grew by only 2.59% on average per year. Director of Livestock production (2002) also showed a similar trend, with coast province, Nyanza and Western Provinces remaining the lowest in milk production due to poor adoption of dairy technologies.

To enhance the production of Dairy cattle in Kenya many programs had advocated for intensive production systems, but with little success. Mukolwe et al (1990) had recommended that cows under zero grazing to be economical needed to produce more than 8 liters of milk per day. Thus with such a recommendation, farmers needed to ensure there was a good breeding and feeding program so as to ensure the average milk production in the farm was not made even lower by long calving intervals. Bebe. (2003) similarly noted that contribution of dairying towards sustaining livelihoods of rural and peri-urban households was likely to be significant only in those areas where there was intensified feeding practices, increased use of external inputs and services.

Despite the above indicated recommendations, no major efforts had so far been put in place to address the challenges affecting production in the various parts of the country, leave alone documenting the levels of adoption of the various technologies versus the production. That partly led to a high turnover of dairy farming, with individual dairy farmers not supported by projects rarely embracing zero grazing in the coastal province of Kenya.(PDLP Coast 2009)

Heifer International Kenya, Coast (2009) for example recorded in its second quarter report of 2009, an average of 6.5 liters of milk per cow per day for its farmers groups in the coastal region with the highest being Taita district at 7.5 liters and Malindi the lowest at 6 liters. With the milk production figures based only on lactating cows, if all cattle supposed to be lactating were considered, the averages would have been lower. The project also recorded high mortality of over 30% of its project cows due partly to nutrition related causes. District Livestock Production officers, Coast. (1998 to 2008) similarly recorded a lower average of 3 liters per cow per day across the province among dairy farmers, which was even lower. The low production was attributed mainly to poor nutrition leading to even longer calving intervals making the enterprise less profitable especially when depending on outside family labor. The factors behind poor adoption of fodder establishment and conservation technologies among small holder dairy farmers are therefore critical as farmers, world over move towards intensive dairy production systems due to population pressure.

The Kenyan government in an effort to spur economic development, in its vision 2030 the economic development blue print, focused on value addition in its livestock products and more so milk, however with such low levels of milk production the vision could remain a vision. Although the government and the various stakeholders have tried to rehabilitate the various dairy infrastructures in the country the challenges in production needed to be urgently addressed for the resources provided not to go to waste.

In Coast province where Heifer International Kenya had since 1992 supported farmers with over one thousand and two hundred dairy cows and supported farmers in Malindi district with two 1 000 liters capacity milk cooling tanks and a batch pasteurizer. However despite the support, the average daily milk collection remained less than 500 litres per day rendering the equipment underutilized. (Heifer International Kenya, 2009)

Other milk processors within the province like Miritini KCC located in Mombasa town which was revived in 2003 by the government to provide an outlet for milk from coast province dairy farmers, unfortunately got all its milk supply for processing from outside the province due to inadequate supply of milk from the region. (Kenya Dairy Board Coast, 2009) The government as if not learning from the milk collection trend of Miritini KCC revived Mariakani dairy cooperative society located within the province and just less than thirty kilometers from Miritini KCC. The plant with a capacity to process over 5000 liters of milk per day faced similar challenges as was unable to take off and risked putting all the tax payers millions of shillings to waste.(PDLP Coast, 2009)

The Strategy for Revitalizing Agriculture (2004) another blue print for economic recovery, had identified the need for the intensification and substitution of agriculture towards more value products rather than expansion of the cultivated area, for agriculture growth to be achieved. However, lack of substantive funding for agriculture and lack of prioritization of research activities was noted to pose risks of duplication by the various players and under utilization of the limited resources. The impact of research findings and technological breakthroughs on agricultural productivity had also been limited because of lack of a comprehensive approach for disseminating research findings. The current extension system also had been noted to be ineffective and inadequate, and thus considered as one of the main causes of poor performance in the agricultural sector. Resources allocated to extension services, which in the first two decade after Kenya gained independence was about 5.9% of the total government annual budget, declined steadily to about 1.7% in the financial year 2003/2004. (Strategy for Revitalizing Agriculture, 2004)

Kenya Agricultural Research Institute having a regional research station in the coast province and sub stations for the region always came up with various technologies to enable farmers enhance dairy production. However with the limited funding, technologies developed were rarely tested on farm in all the coastal zones leave alone implementing the farmer demand driven research so as to enable farmers make informed decisions on any dairy technologies of interest. (Kenya Agricultural Research Institute 2008) That led to projects making blanket recommendations to farmers on dairy technologies to be adopted. Heifer International Kenya for example, promoted the establishment of at least one acre of Napier grass (*Pennisetum purpureum*) and 500 fodder trees beside a zero grazing feeding system for its farmers across the whole country and other project countries like Cameroon regardless of diverse environmental conditions, thus leading to various implementation challenges (Njwe et al 2001*)*. During the year 2008, over 80% of the dairy farmers supported in the coast province Kenya by Heifer International Kenya who stood at over 1200 had less than a half an acre of Napier grass while over 60% of the zero grazing units were in poor conditions with only three farmers in the whole of the coast province under the project having been able to make silage. On the other hand apart from those storing maize stovers none of the project farmers baled hay during the period. Director of Livestock Production (2008) had equally identified fodder conservation and establishment as being critical for intensive dairy production especially in the coast province of Kenya where adoption of agriculture technologies was always low. However no strategies were put in place to address the challenges.

While comprehensive studies for dairy technologies adoption in the Coast province were done in the 1990's by NDDP and (Thorpe et al 1999), among others, the main focus was on Napier grass, dairy cattle and disease control. Very little was done on fodder conservation and the zero grazing challenges. Nicholson et al (1999) on adoption and impact of dairy technologies in the coastal lowlands among smallholder dairy farmers noted that adoption of dairy technologies was low for the Mijikenda tribe compared to the other tribes especially from other parts of the country. Wekesa et al (2003) similarly on a

study on the adoption of maize technologies in Kwale and Kilifi districts also found that the Mijikenda were keen adopters of new technologies if they deemed them worth wile. While both studies identified challenges in adoptions of agricultural technologies in the coast province, no subsequent projects had come up with either an in depth study on the same or intervention.

Maarse (1995) noted that women performed most of the work in most dairy production enterprises but very little done to come up with technologies that would ease their labor burden leave alone unearthing its influence on dairy technology adoption. A study done in Kilifi district on labor distribution in dairy production indicated that women performed 30% of dairy activities, men 20%, hired labor 18%, children 26% and others 6%. (National Dairy Development Program 1990). However the primary school enrolment rate in 1990 was 18% while currently with an improved enrolment rate of over 60% in coast province, little was done to show its effect in dairy production. (Kilifi, Malindi and Kwale District Development Plans 2009)

The low milk production in developing countries occasioned by poor adoption of technologies needed to be addressed for the smallholder farmer to enhance their income. FAO (2010) reported that, Asia owned 25.7% of the dairy cattle in the world but produced 14.9% of the world milk, while North America with 5% of dairy cattle population produced 16.3% of the world milk. Africa on the other hand with a massive 14.2% of the world dairy cattle population accounted for only 4.7% of the world milk production which was far below its requirement. The disparity in production attributed to breeds and feeding mainly ought to be an eye opener to developing countries. In Kenya the trend was similar to that of Africa with the Kenyan coast producing very little milk and remaining a net importer of milk all year round. The smallholder dairy farmers who owned the bulk of dairy cattle population in the world therefore deserved a lot of attention if any meaningful development was to be realized.

The study therefore sought to determine the factors influencing adoption of dairy technologies in the Coast province of Kenya so as to come up with recommendations for use by livestock extension staff, researchers, policy makers, farmers and development agencies in the dairy sub sector.

1.1 Statement of the problem

While the average yearly growth of dairy cattle population in Coast province stood at 4.4% from 1998 to 2008 the average yearly milk production growth was a mere 2.59%. During the same period Malindi district registered a -0.49% dairy cattle and -0.6% milk production growth rate occasioned by loss of cattle, farmers pulling out of dairy farming and poor feeding. Kwale district on the other hand registered an average yearly growth rate of 5.64% and 5.63% for the dairy cattle population and milk production respectively. Kilifi district registered 5.53% and 5.95% average yearly growth in population and milk production, The average milk production per cow per day was 3.0 liters for coast province, 1.8 liters for Kilifi district, 3.7 liters for Malindi district and 2.3 liters for Kwale district and was attributed to poor nutrition and long calving intervals.(District Livestock Production Officer's Coast 1998-2008)

(Bebo, 2003; Director of Livestock production, 2008) variously indicated that Coast, Western and Nyanza Provinces were poor in adoption of dairy technologies with Poor nutrition of livestock being recorded as the main reason for poor livestock production.

As farmers sluggishly embraced fodder establishment and conservation technologies which are prerequisite for sustainable and intensive dairy production, few studies if any had been done to find out the reasons as to why farmers failed to adopt the dairy technologies in the Coast province, Kenya; hence the rationale behind this study.

1.2: Purpose of the study

The purpose of this study was to establish the factors influencing adoption of dairy technologies in Coast province, Kenya.

1.3: Objectives of the study

The study was guided by the following objectives.

1. To establish the extent to which market availability influenced adoption of dairy technologies in Coast province, Kenya.

2. To assess the relationship between labor availability and adoption of dairy technologies in Coast province, Kenya.

1.4: Research Questions

The study aimed to address the following Research Questions..

1: To what extent does market availability influence adoption of dairy technologies in Coast province, Kenya?

2: What is the relationship between labor availability and adoption of dairy technologies in Coast province, Kenya?

1.5: Significance of the study.

This study sought to determine the factors influencing adoption of dairy technologies in the Coast province, Kenya and suggest interventions necessary for improved adoption.

The policy makers would be able to use study findings in prioritizing project implementation in various parts of the country.

Extension service providers would also, apart from knowing the current adoption status for the various technologies get the challenges limiting. The factors based on the technology characteristics would form a basis for them to review both the technologies and mode of delivery. The extension staff would also be able to use the results for working out possibilities of linking the farmers for specific interventions like credit or specialized training.

Project financiers or those intending to go into dairy farming would be able to know whether the identified challenges for the projects were workable for the enterprise to remain profitable.

Projects and individuals interested in dairy production and processing would be able to use the findings to make informed decisions on the extent and area to invest based on the various challenges identified in the various areas.

Researchers and scholars would be able to use the findings as a basis for further research.

1.6: Definition of significant terms used in the study

Dairy technologies: These are the aspects in dairy production which enhances success of the project and they include; disease control, proper feeding, housing, fodder establishment and conservation, zero grazing, selection of appropriate dairy cows, breeding among others. For the purpose of this study dairy technologies would be, zero grazing, Napier grass establishment, silage making and hay baling.

Adoption: This refers to the degree of practicing the recommended practice.

Technology: Mahajan et al (1985) defined technology as any idea, object or practice that is perceived to as new by the members of a social class.

Project financier: These are the organizations or individuals supporting the dairy project through provision of inputs or training support.

Zero grazing. This is a cattle feeding system where the cows are confined in a structure.

Project operation guidelines: This means the regulations given by the project financier or the group towards management of the dairy cattle.

*Fodder establishment***:** Means growing of Napier grass and or fodder trees for the purpose of feeding the zero grazed cattle.

Fodder conservation: Means making of silage or and hay for the *purpose of feeding the zero grazed cows.*

*Dairy***:** Means cattle kept for milk that is pure breed dairy cows or crosses.

Silage: This refers to fermented high moisture fodder to be fed to intensively reared cattle. Silage is made by placing cut green grass in a silo, or by pilling it in a heap covered with plastic sheet, or by wrapping large bales in plastic film.

*Hay***:** Refers to grass, legumes or other herbaceous plants that have been cut, dried, and stored for use as animal fodder, particularly for dairy cattle.

Smallholder dairy farmer: This is the farmer with less than 10 milking dairy cows and less than 15 acres of land.

Market availability: This is the distance in Kilometers to main source of milk market.

Labor availability: This is the number of household members doing dairy work and the number of hired laborers.

2. Literature Review

2.1: Influences of market availability on adoption of dairy technologies

Thorpe et al (2000) noted that in Eastern Africa just as many parts of the tropics, market availability played a key role in promotion of smallholder dairy production. Many smallholder dairy farmers were variously concentrated near or within urban areas so as to easily access market. Makokha (2005) observed that households in Western Kenya invested little effort to increase milk production despite the existence of a large milk market and partially unmet milk demand. Population density was used as proxy to market in the study which did not however highlight on both the feeding habits of the population or the milk demand potential since the study focused on a rural community. Likewise the study never captured the specific factors limiting adoption of the various technologies which enhanced milk production. The inferences made based on the farmers characteristics therefore were not conclusive on why farmers never adopted the various technologies.

Mekonnen et al (2009) on a study on dairy technology adoption in smallholder farms in Dejen district of Ethiopia found that technology adoption among smallholder dairy farmers was still low and proximity of the farm to market increased the adoption of dairy technologies. The study however never indicated the other factors which could have influenced the adoption beside proximity to market. Redda, (2001) had also observed that in Ethiopia, farmers' milk marketing groups were essential in dairy development and

necessary to overcome the problems of collection, transportation, processing and marketing of milk. The establishment of producers' organizations was necessary and needed to be strengthened through accelerated training and extension education programs.

Staal et al (1997) while on a study on characterization of dairy systems supplying the Nairobi milk market observed that the underlying strategies of smallholder dairy farmers for coping with land pressure and market forces were not well known making the success of smallholder dairying depending on the producers' ability to adapt to prevailing challenges. However one critical outcome of the study was that the resource poor smallholder dairy farmers with limited access to services and formal market were vulnerable to the changing conditions. While similar challenges existed in the Coast province of Kenya as those from the study area, the differences in socio-economic characteristics also influenced how farmers coped with prevailing challenges. That therefore made it necessary for region specific studies which had potential of coming up with both technology and farmer characteristics influencing adoption. Staal, S. J and Kaguongo, W. N (2003) had also observed that in Uganda there was need for establishing the extent to which milk market infrastructure influenced the smallholder dairy production since seasonal milk surpluses and milk consumption levels had been identified as challenges. Inadequate data on informal milk share which was necessary in targeting formal milk market development adversely affected intervention efforts. Poor milk market therefore made adoption of the various dairy technologies which enhanced milk production untenable.

Baltenweck, (2000) reported that policy changes over time played a key role in adoption of various dairy technologies in Kenya since the availability of reliable market channels and livestock services after liberalization in 1992 shifted down the adoption function of Grade Cattle Technology in Kenya. However despite the liberalization of market other factors ought to be influencing the adoption of the dairy technologies in the country since liberalization did not necessarily influence market availability negatively to all smallholder dairy farmers. That therefore called for studies to determine the various dairy technologies adoption decisions among smallholder dairy farmers in various parts of the country so as to come up with workable interventions. Waithaka et al (2002) had also recommended for further studies of the factors influencing the predominance of subsistence production and less market orientation and specialization among smallholder dairy farmers. Similarly Unreliable milk market, high prices of drugs and concentrates were identified as the major challenges to small scale dairy farming in Karagwe district of Tanzania (Lwelamira et al 2010).

2.2: Influence of labor availability on adoption of dairy technologies

Nicholson et al (1999) in their adoption and impact survey of smallholder dairying in three districts of coastal Kenya notably Kwale, Kilifi and Malindi found out that labor availability influenced adoption of dairy technologies. The study however, used family size as proxy for labor availability which could have been misleading as not all household members participated in dairy activities. The above factors as earlier observed are the characteristics of the adopters which may not necessarily be able to lead to a conclusion that they were the clear reasons behind adoption of the technologies (Doss ,2006). While the study focused on Napier grass establishment, it never indicated the extent of adoption. Also the study while looking at the labor availability never identified the family members who contributed directly to the dairy activity but focused on the total family members as a proxy to labor which could have given a misleading impression. Mureithi et al (1998) while assessing the factors which influenced adoption of forages in smallholder dairy farms in the coastal lowlands of Kenya also identified labor shortage, land ownership rights, inadequate capital which was compounded by fear for acquiring credit by the community and

seasonal availability of natural forage and profitability of the enterprise as some of the factors which affected adoption of dairy technologies. The study was done using a participatory methodology called Participatory Rural Appraisal (PRA) in four different administrative locations two in the current Malindi district which was then part of Kilifi district and two in the remaining Kilifi district. Although the methodology used had the potential of gathering a lot of data the findings could have been compromised by subjective considered views of a few participants

Jackline (2002) in an adoption study in Uganda found membership to a farmer's organization, size of farm holding and level of education as non significant factors in technology adoption. Farmers participation in on farm demonstration and farm labor availability were however influential in integrated pest management technology adoption. Chipande(1987) on a study on agricultural innovation adoption among female headed households in Malawi found labor deficiency and in appropriate innovation packages as the main constraints in innovation adoption. This therefore indicated that farmers adopted technologies while being fully aware of their environment and that almost always made changes before adopting. The level of technical knowledge and socio-economic constraints always informed their decisions. Farmers' perceptions of the attributes of an innovation, not necessarily the attributes as perceived by extensionists, scientists or politicians, influenced adoptive behavior. Mekonnen et al (2009) had also realized that the larger the family sizes the higher the adoption levels of dairy technologies. The study used family size as a proxy for labor instead of participating family members thus the inferences could be misleading as having many family members did not necessarily mean they provided labor for dairy production.

2.3: Theoretical framework

Three Models have over the years been used in agriculture technology adoption studies as below.

The innovation diffusion model, which entails that access to information, is a critical factor in the adoption and diffusion of technologies. (Feder et al 1985; Shampine 1984) suggested for the need for emphasizing the use of extension; visits, farm trials and other means to transmit technical messages so as to cut on the search costs for technology thus enhance adoption. This model is influenced by farmers characteristics like age, education among others.

The second Model is *the economic constraint model* which purports that economic constraints are major determinants to adoption. (Smale et al 1994; Shampine 1998) stated that in the short run with inputs being limited adoption of technologies was challenged. However in the long run adoption decisions become feasible. This showed why technologies which appeared like having been rejected ended up being adopted after farmers long term planning.

The third Model is the *adopter perception paradigm* which focuses on perceived attributes of the technology. (Norris and Batie 1987) noted that even with full technical information, farmers subjectively evaluated the technology different from scientists. This therefore calls for periodic studies on technology adoption so as to address any gaps.

Langyintuo et al (2005) observed that since each of the three models focused on a few attributes it was necessary to use all of them for meaningful inferences to be made.

Doss (2006) indicated that farmers were usually able to provide information on why they did not adopt a new technology and sometimes the answers provided were able to provide insights into the constraints facing the farmers, while other times, multiple constraints were binding so that removing the listed constraints did not necessarily result in the farmer's adoption of the technology. This therefore pointed to

the necessity of adoption studies so as to enable informed decisions in projects implementation. The study therefore used all the three adoption models.

2.4 Conceptual framework

Market availability for milk is considered a critical factor influencing adoption of the various dairy technologies. Farmers are expected to adopt the four dairy technologies under study so as to enhance and sustain milk production where the market was guaranteed. Therefore farmers travelling the shortest distance to main milk market source have a high chance of investing in terms of adopting the various technologies so as to sustain production and income.

With the four technologies being labor intensive, households with a big number of household members assisting in dairy work had higher chances of adopting the four technologies compared to those with small number of household members doing dairy work. On the other hand farmers with the ability to hire laborers to do dairy work also stood high chances of adopting the stated dairy technologies.

Two independent variables defined the study that is market and labor availability. Market availability was based on the distance to the main milk market while Labor availability was based on the number of household members doing dairy work and number of hired laborers.

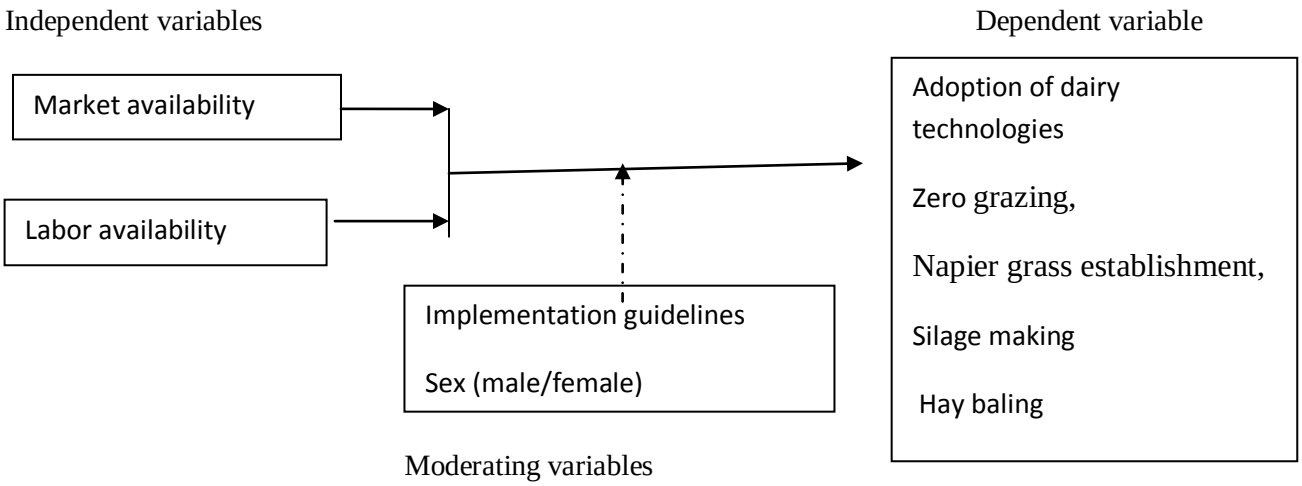
The dependent variables were Zero grazing months per year, acreage under Napier grass, Number of times made silage and number of times baled hay.

For a farmer to adopt the indicated technologies labor played a critical role. However even where labor was available the market needed to be guaranteed. The two independent variables therefore depended on each other.

The one financing the project on the other hand issued implementation guidelines on technologies to be adopted whether it made economic sense or not. In this study apart from the project financier having guidelines to be followed in terms of technologies to be adopted, the farmers groups also had governing rules which motivated adoption.

Where the owner had other sources of income ploughed into the project or mobilized family labor then adoption of the technologies was enhanced. Therefore where the owner of the cows was a woman, other reproductive roles constrained adoption of the various technologies especially where capacity to hire labor was limited and existing family labor was inadequate..

Figure 1.1 conceptual framework



3. Research Methodology

3.1: Research design

The study adopted a cross sectional survey research design as used by Nicholson et al (1999) while on an adoption and impact survey of dairy technologies in Coastal Kenya. Both qualitative and quantitative data was collected.

3.2: Target population

The target population was 227 smallholder dairy farmers from Coast province Kenya from which the sample was drawn. Smallholder dairy farmers from Kilifi, Malindi and Kwale districts supported by Heifer International Kenya from the year 2000 to 2002 and Self financed smallholder dairy farmers with over fifteen years experience in dairy farming from the three districts formed the target population. The research targeted both male and female smallholder dairy farmers with dairy cows as at the time of the study.

The districts were selected as were home to the three main Mijikenda sub tribes keeping dairy cattle and were among the districts covered by the former National Dairy Development Project and Heifer International Kenya projects which advocated for the technologies under study.

3.3: Sampling procedure and sample size

3.3.1: Sampling procedure

Probabilistic random sampling was used in the study so as to come up with the representative sample. Stratified random sampling was used so as for the three districts under study to be well and fairly represented. Purposive sampling was used for gathering information on staff technical and practical competence on the technologies under study from the District Livestock Production officers, Provincial Director of Livestock Production Coast and the Heifer International Kenya Coast representative.

3.3.2: Sample size.

The study had a sampling frame of 227 farmers drawn from the three districts that is 81 from Kwale, 77 from Malindi and 67 from Kilifi district. The list was developed by the District Livestock Production Officers Kilifi, Malindi, Kwale and the Heifer International representative for Coast region

Table 3.1: Target population for the study

District	HIK financed farmers	Self financed farmers	Sample size	Percentage
Kwale	66	15	25	36
Kilifi	50	19	21	30
Malindi	55	22	24	34
Total	171	56	70	100

3.4: Data collection instruments

The data collection instrument used was a questionnaire, document analysis and observations as detailed below.

3.4.1: Questionnaires

Questionnaire was the main data collection instrument for collection of primary data. A structured questionnaire with both open ended and close ended questions was used for ease of interpretation and also gathering a wide range of data. One questionnaire targeted the smallholder dairy farmers and another one targeted the extension service providers that is the District Livestock Production officers, the Provincial Director of Livestock Production, Coast and the Heifer International Kenya Coast Representative.

3.4.2: Document analysis.

Farmers production and breeding records were analyzed for coming up with calving interval, average milk production by the cows in the farm, average milk prices, main source of inputs and extension services and other challenges faced by the farm. The data gathered complemented that gathered from the structured questionnaire.

3.4.3: Observation

Observation was used to ascertain on data provided from the questionnaire especially on Napier acreage, Zero grazing status, Silage and hay baled.

3.5: Data collection procedures.

Interview Schedule was used as a method of data collection and the data collected by the Researcher rather than through a self-administered questionnaire. The Researcher read the questions exactly as they appeared on the survey questionnaire, however clarification was provided where respondents misunderstood the question The data collection procedure was chosen as recommended by (Mugenda, O. M and Mugenda, A. G 2003) for respondents who are not able to read and easily understand the questions.

3.6: Data analysis techniques.

Data collected was scrutinized, coded and analyzed using Statistical package for social scientists (SPSS). Descriptive statistics was used to describe the socio-economic characteristics of the respondents where computation of means was the main analytical tool used in this exercise. Correlation(r) was also analyzed and the error permissible 0.05 (α).

4. Data Presentation, Analysis and Interpretation.

4.1 Response rate

The study had targeted to sample 70 smallholder dairy farmers and was able to realize 100% of the sample. The three District Livestock Production Officers, the Provincial Director of Livestock Production Coast and Heifer International representative Coast province were Livestock production and the Heifer International Coast representative were interviewed as proposed. The high response rate was achieved as there was good mobilization and coordination.

4.2 Demographic Characteristics.

A demographic characteristic by location and sex is provided in this section.

4.2.1: Demographic characteristics by district.

The study focused on the various demographic characteristics by district. The characteristics included, distance to main source of market, education level, number of household members doing dairy work, number of hired laborers, off dairy income, land size and fodder acreage among other factors. The sample comprised of 25 farmers from Kwale 20 financed by HIK and 5 self financed, 21 farmers from Kilifi district out of which 13 were supported by HIK and 8 were self financed. There were 24 farmers from Malindi district 19 financed by HIK and 5 self financed.

The average age of the farmers in the three districts was above 50.13 years and standard devi0ation of 13.41 for Kwale and Malindi. Kilifi had a mean age of 56.52 and standard deviation of 9.448. Dairy farming was in the hands of old people in all the three districts.

Kwale had the highest mean level of education attained at 9.32 and standard deviation of 5.328. Kilifi had a mean education level of 6.81 and standard deviation of 5.446. Malindi district had the lowest mean highest education level attained at 4.83 and standard deviation of 4.86. Farmers from Kwale district therefore had a better capacity of acquiring dairy technologies and instructions which required some level of education since the average indicated that most farmers surveyed had gone past primary level of education compared to Kilifi and Malindi districts most of whose farmers had not gone past primary level of education.

Malindi district had the highest number of household members doing dairy work at 4.42 and standard deviation of 3.035 followed by Kwale district at 2.8 and standard deviation of 1.871. Kilifi had the lowest number of household members doing dairy work at 1.48 and standard deviation of 0.602. On hired labour 40% of households in Kwale district had a hired laborer, Kilifi district had 43% while in Malindi district had 17%.of its farmers with hired laborers. Therefore smallholder dairy work was mainly in the hands of household members in Malindi district as compared to Kwale and Kilifi districts which depended on both hired labour and household members.

The average land size per farmer in Kwale was 3.64 acres and a standard deviation of 3.108. In Kilifi the average land ownership was 6.559 acres with a standard deviation of 4.663 while in Malindi district the average was 7.198 acres with a standard deviation of 4.502. Farmers in Kwale district therefore had small land parcels for both crop and fodder establishment compared to Kilifi and Malindi districts. However in Kwale district all farmers owned the land they occupied while in Kilifi 14% of the farmers were in family land which had not been sub divided and in Malindi district 40% of the farmers were in family land which had not yet been subdivided making decision making on use mode a challenge.

On fodder establishment only 12% of the farmers surveyed from Kwale had one acre and above of Napier grass as at the time of the study while Kilifi and Malindi districts had no farmer with one acre or above of Napier grass. 20% of the farmers from Kwale had baled hay at least once and 12% had made silage. In Kilfi district 10% of the farmers had made silage while none had baled hay. Malindi district had none of its farmers who baled hay or made silage since started dairy farming. That indicated that Kwale district farmers were batter in testing or adopting technologies compared to both Kilifi and Malindi districts.

Based on the source of funding for the purchase of the cows it was observed that 42% of HIK financed farmers across the three districts had Napier grass ranging from 0.17 acres and 1.0 acres while from self financed farmers only 33% had a similar acreage. 8% of HIK financed farmers had baled hay at least once while 6% of self financed farmers had baled hay. On silage making 6% of HIK financed farmers had made silage while 11% of self financed farmers had made silage at least once. 77% of HIK financed farmers had their cows under zero grazing while only 33% of self financed farmers were under zero grazing.

Most farmers in the three districts owned between two and three dairy cows. The average amount of milk per cow per day was 3.12 litres and standard deviation of 4.585 liters in Kwale district and 4.95 litres and a standard deviation of 3.471 liters' for Kilifi district and 4.12 litres and a standard deviation of 4.174 liters for Malindi district. The average highest amount of milk produced by the best cows in Kwale district was 14.16 liters', and standard deviation of 4.939. In Kilifi it was 12.62 and standard deviation of 4.177. For Malindi district the average was 10.54 and a standard deviation of 4.128. The average calving interval was about 20 months against the recommended 12 months while each farmer from the three districts had lost an average of one cow within the previous three years preceding the study.. The milk production levels and the long calving intervals made zero grazing uneconomical especially with hired labor. The highest milk production by the farmers' best cows indicated that the cows had potential for high milk production.

It was established that of the farmers sampled 88% from Kwale district had their cows under netted zero grazing units due to the high prevalence of Tsetse flies in the district while Kilfi district had 57% of the farmers with their cows under zero grazing while 42% of farmers from Malindi district had their cows under zero grazing. Over 60% of the zero grazing units across the three districts were in poor condition and the cows were tethered in the zero grazing units. The trend showed that farmers were tending towards semi intensive grazing system due to labor constraints.

4.2.2: Demographic characteristics by Sex

The study focused on the various demographic characteristics by sex The characteristics included, distance to main source of market, education level, number of household members doing dairy work, number of hired laborers, off dairy income, land size and fodder acreage among other factors as indicated in tables 4.3 and 4.4 and explanation that follows.

The sample comprised of 11 male and 14 female farmers form Kwale 6 male and 15 female farmes from Kilifi district, 10 male and 14 female farmers from Malindi district. The survey comprised of 27 male and 43 female farmers.

The average age of the farmers was 51.21 years and a standard deviation of 10.4 while that of the males was 53.41 with a standard deviation of 13.913. Therefore the difference in age between the male and female farmers was not very wide implying that the farmers were mostly above 50 years old.

On education, male farmers had a mean education level of 8.67 and standard deviation of 5.299 compared to female farmers of 6 years and standard deviation of 5.385.

It was also established that 30% of the female farmers had hired laborers while 37% of the male farmers had hired laborers.

Female farmers had an average of 4.349 acres and standard deviation of 3.493 while male farmers had an average acreage of 7.944 acres and standard deviation of 4.728 acres. Male farmers were advantaged when it came to decision making for fodder establishment. On Napier grass acreage 4% of the male farmers had one acre of Napier grass and above while 5% of women had one acre of Napier grass and above.

The average amount of milk produced per cow per day was 3.37 litres and standard deviation of 3.723 for female farmers while for male farmers it was 5.04 litres and a standard deviation of 4.628. Male farmers produced more milk per cow per day compared to female farmers. For the other variables notable, caving interval, distance to source of inputs, extension services and main milk market the differences were not very alarming since both male and female farmers were operating within similar environment.

4.3: Influence of Market and labor availability on adoption of Zero grazing.in Coast province Kenya

4.3.1 Correlation between market availability and zero grazing

Market availability was based on distance to milk market. The Pearson correlation coefficient between distance to main milk market and zero grazing was 0.183 with a p value of 0.065. Therefore at $p<0.05$ it is not significant. That is there is no significant relationship between distance to main milk market and adoption of zero grazing.

4.3.2 Correlation between labor availability and zero grazing.

Labor availability was based on household members doing dairy work and number of hired laborers doing dairy work. The Pearson correlation coefficient between household members doing dairy work and zero grazing was 0.216 and the p value was 0.036 therefore at $p<0.05$ was not significant thus no significant relationship existed between them. On laborers doing dairy work the correlation coefficient was 0.087 with a p value of 0.238 thus not significant at $p<0.05$ indicating no relationship between the two variables.

4.3.3 Other factors influencing adoption of Zero grazing

Inadequate labor was one of the main challenges to zero grazing across the three districts and also by both male and female farmers at 82%. Zero grazing being labor intensive, most farmers were constrained due to either small number of household members assisting in dairy work or inability to hire laborers

Women did most of the dairy work in 36% of households sampled. Laborers followed in 33% of the households, men in 24% of the households, sons or daughters in 4% of the households and finally other relatives in 3% of the households. With most of the work in the hands of women only 64% of cows were under zero grazing with the zero grazing units in poor condition. Another challenge for zero grazing was silent heat for the cows thus leading to long calving intervals. The average calving interval was 20 months across the 3 districts against the recommended average of 12 months. Apart from the difficulty in observing the heat while the cows were under zero grazing it was observed that farmers both underfed the cows and only 14% of the farmers had mineral supplements for their cows a factor contributing to silent heat. Mukolwe et al (1990) had indicated that a cow under zero grazing needed to produce at least 8 liters' per day. With the long calving interval the average milk production per cow per day in the 3 districts was

4.01 liters with a standard deviation of 4.144. Wambugu (2004) had also recorded an average of 5.5±3.5 liters of milk per cow per day in Kiambu district, which was far below the cows' potential. The daily milk production average observed in the three districts was also similar to the coast provincial average which was 3.0 liters for the period between 1998 and 2008.

Unreliable and erratic rainfall which affected fodder establishment also affected zero grazing since fodder produced was not able to sustain the cows all year round. The cost of maintaining a zero grazing unit was also considered a hindrance to adoption of zero grazing and that was why some of the sampled farmers had pulled out of zero grazing while some of those practicing en route to semi zero grazing. Disease challenges were also considered a challenge to zero grazing especially where one was supposed to take care of dry cows. Those challenges made farmers opt for semi intensive dairy production system.

4.4 Influence of Market and labor availability on Napier grass establishment in Coast province Kenya

4.4.1 Correlation between market availability and Napier grass acreage

Market availability was based on distance to main milk market. The correlation coefficient between distance to main milk market and Napier grass acreage was -0.007 with a p value of 0.478. Therefore at $p<0.05$ it was not significant. That is there was no significant relationship between distance to main milk market and Napier acreage.

4.4.2 Correlation between labor availability and Napier grass acreage

Labor availability was based on household members doing dairy work and laborers doing dairy work. The correlation coefficient between household members doing dairy work and Napier acreage was -0.068 and the p value was 0.288 therefore at $p<0.05$ was not significant thus no significant relationship existed between them. On laborers doing dairy work the correlation coefficient was 0.123 with a p value of 0.154 thus not significant at $p<0.05$ indicating no significant relationship between the two variables.

4.4.3 Other factors influencing adoption of Napier grass establishment.

The main factor influencing the adoption of Napier grass establishment was unreliable and erratic rainfall in the three districts. Despite the three districts receiving between 700 mm and 1200 mm of rainfall per year its distribution was not reliable (PDA 2008). This therefore made it necessary for farmers to be always sourcing for Napier grass planting material for replanting.

The average acreage of Napier grass per farmer in the three districts was 0.17 acres which was far below the recommended one acre per cow. The highest average acreage of Napier grass each farmer had planted since started dairy farming was 0.75 acres which was also low considering the challenges in rainfall thus making the dry matter production per acre lower.

The other challenge identified was free grazing by neighbors' livestock especially during the dry spell. Mureithi et al 1998 in a similar study in the three districts also identified a similar challenge. The problem is aggravated by lack of fencing by most farms thus making it easy for penetration of livestock into Napier fields. Inadequate labor for Napier establishment was also a challenge especially where the woman was the one supposed to plant and tend Napier fields.

In Kwale district, high availability of natural pasture discouraged farmers from growing Napier grass as it was seen as an unnecessary cost. Mureithi et al (1998) had also identified the availability of natural pasture as a hindrance to Napier grass establishment in Coast province.

Land ownership problem also made fodder establishment a challenge especially where one was to fence off the Napier plot to guard off livestock.

Other farmers had other reasons like infestation of the established Napier grass by pests and diseases and lack of technical knowhow as challenges to Napier establishment.

4.5 Influence of Market, labor and extension services availability on adoption of silage making in Coast province Kenya

4.5.1 Correlation between market availability and silage making

Market availability was based on distance to milk market. The correlation coefficient between distance to market and silage making was -0.050with a p value of 0.340. Therefore at $p<0.05$ it is not significant. That is there is no significant relationship between distance to market and Napier acreage.

4.5.2 Correlation between labor availability and silage making

Labor availability was based on household members doing dairy work and hired laborers doing dairy work. The correlation coefficient between household members doing dairy work and silage making was 0.034 and the p value was 0.388 therefore at $p<0.05$ was not significant thus no significant relationship existed between them. On laborers doing dairy work the correlation coefficient was 0.070 with a p value of 0.282 thus not significant at $p<0.05$ indicating no relationship between the two variables.

4.5.3 Other factors influencing adoption of silage making

The main challenge to silage making was inadequate fodder for ensiling. This was mainly contributed to by the fact that the acreage of Napier grass was not adequate for feeding the cows and ensiling. The farmers only knew of Napier as the only fodder they could consider for silage making. Nakamanee (1997) also identified insufficiency in locally available material to be ensiled as a challenge to silage making in Thailand.

The other challenge was inadequate technical knowhow. Farmers therefore found silage making was out of reach for them as they believed a lot of fodder was required for silage to be made and also even for those familiar with silage making knew only the pit silage making technique. That problem cut across all the farmers interviewed.

The technical knowhow of the extension staff of the ministry of livestock in silage making was also wanting as the sampled offices had only 31% of its technically staff competent on more than one silage making technique. Therefore farmers had limited choices in terms of the silage making technique to adopt. (0jieda 1999, Nakamanee 1997) also identified lack of technical knowhow by extension agents as the reason hampering silage making techniques.

The other challenge to silage making was high availability of natural pasture that made farmers find silage making unnecessary. This was especially so in Kwale district where farmers living near valleys and rivers had steady supply of fodder. Also due to low livestock population in Kwale district farms with natural pasture offered fodder that was harvested during dry spell.

Inadequate labor was also identified as a challenge which discouraged farmers from silage making especially when compared with the output from cows with long calving intervals.

High cost of ensiling material affected adoption of silage making by some farmers. However that was also contributed by the fact that the farmers were not fully informed on the various silage making recipes and

techniques as they were only aware of Napier grass and molasses. Nakamanee (1999) also noted that the cost of ensiling technology repulsed farmers from adoption especially where it was not commensurate with the available capital on the farms in Thailand.

4.6: Influence of Market and labor availability on adoption of hay baling in Coast Province, Kenya

4.6.1 Correlation between market availability and hay baling in Coast Province Kenya

Market availability was based on distance to milk market. The correlation coefficient between distance to market and hay baling was 0.010 with a p value of 0.466. Therefore at $p<0.05$ it is not significant. That is there is no significant relationship between distance to main milk market and hay baling

4.6.2 Correlation between labor availability and hay baling

Labor availability was based on household members and laborers doing dairy work. The correlation coefficient between household members doing dairy work and hay baling was -0.167 and the p value was 0.172 therefore at $p<0.05$ was not significant thus no significant relationship existed between them. On laborers doing dairy work the correlation coefficient was 0.056 with a p value of 0.322 thus not significant at $p<0.05$ indicating no significant relationship between the two variables.

4.6.3 Other factors influencing adoption of hay baling

The main challenges to hay baling included inadequate technical knowhow, inadequate labor, inadequate pasture for baling, inadequate storage facilities and high availability of natural pasture.

Out of the 70 farmers sampled only 7% had baled hay and were all from Kwale district. No farmer from both Kilifi and Malindi had ever baled hay.. The main mode of fodder conservation however was the use of maize stovers which although supported the cows during the dry spell required a lot of storage space compared to baled hay.

Most farmers were keen on the hay baling technology but expressed concern that had not been sensitized. As for those who had baled, only one baling technique was known to them.

Inadequate labor for baling was also of concern as most of the work was in the hands of the women, laborers or men who had little time to spare for hay baling.

High availability of natural pasture was discouraged farmers from hay baling since it was viewed as an added cost.

Inadequacy of hay storage facilities also affected adoption of hay baling technology since baling required an extra cost for construction of a store to ensure the hay was protected. Inadequate pasture for baling was also observed as a challenge for hay baling especially in areas of small land sizes which were also used for food crop farming thus leaving little room for fodder establishment and harvesting for feeding the livestock and baling.

Hay baling was also a challenge to the staff of the Ministry of Livestock Development charged with the responsibility of educating farmers on the technology. Only 38% of the surveyed extension staff was practically competent on more than one hay baling technique.

5. Summary of Findings, Conclusions and Recommendations.

5.1: Summary of findings.

The study aimed at determining the key factors influencing the adoption of dairy technologies in the coast province of Kenya. The study therefore aimed to establish whether market and labor availability had any influence on the adoption of dairy technologies in Coast province, Kenya.

Due to increasing population pressure and need for intensive agricultural production systems the study focused on zero grazing as a feeding system, Napier grass establishment, silage making and hay baling. The results from the study were not only to be beneficial to the farmers from coast province but also to other dairy farmers using the stated technologies and also the various stakeholders in dairy production.

Literature on the area of study has reported various challenges to adoption of the various technologies. Market availability where various proxy's to market including distance to nearest trading centre, distance to source of market have been used to indicate market availability whereby it has been reported that farmers with a reliable market source were most likely to adopt various technologies.

Labor availability has been reported as a major factor influencing adoption of dairy technologies especially the ones which are labor intensive like Napier grass establishment and zero grazing. Inadequate resources in terms of finances and more so land resources have also been key factors in adoption of the technologies. Education level of the farmers also influenced technology adoption.

The challenges to adoption of the various technologies have thus been as diverse as the areas the studies were done. This has been contributed by the various proxies' used for the various factors and the methods of data collection and analysis.

The study used a cross sectional survey research design where 70 smallholder dairy farmers were sampled from three districts of coast province notably Kwale, Kilifi and Malindi. The data gathered was analyzed using SPSS and mean, frequency tables, descriptive statistics and correlation used for making inferences based on the objectives and Research questions

The study was able to establish that adoption of zero grazing was not correlated with labor and market availability. It was also evident that farmers considered labor availability challenges as the main hindrance to zero grazing. This was caused by the fact that family labor was not readily available due to formal education and hired labor was getting more expensive. Therefore a cow needed to produce at least 3 litres per day all year round just for the hired laborer. The other challenge with the laborers was that most laborers terminated their services without notice thus making dairy farmers always searching for laborers, as women filled the gaps left by laborers.

No significant relationship was established between Napier grass establishment and market availability and labor availability. The main challenge towards establishment of Napier grass was unreliable and erratic rainfall necessitating replanting every season thus increasing production costs. Other reasons were grazing by neighbors' livestock thus necessitating fencing which was expensive or challenging where land was still communally owned. The other factor was inadequate labor since Napier grass establishment and maintenance was labor intensive. The average Napier acreage was 0.17 acres per farmer in the study area which was far below the one acre of Napier grass advocated for per cow.

Silage making also had no correlation with market and labor availability.The main challenge to silage making identified was inadequate fodder for ensiling. This was contributed by the fact that the average Napier acreage for the three districts was only 0.17 acres which was not enough for even one cow.

Inadequate silage making know how also hampered silage making. Other farmers identified high availability of natural forage as discouraging them from silage making. Only 10% of the farmers had made silage since they started dairy farming.

Hay baling had no correlation with market and labor availability Inadequate hay baling knowhow was the main challenge to hay baling by most farmers. Most farmers however stored maize stovers for dry season feeding. Labor for hay baling was also limited and thus a challenge. High availability of natural pasture also discouraged farmers from hay baling. Only 7% of the farmers had baled hay since they started dairy farming and were all from Kwale district.

5.2: Discussions of the study findings

The study established that market availability never influenced adoption of the four dairy technologies under study. These findings are similar to findings by (Makhoka 2005) who reported that households in Western Kenya invested little effort to increase milk production despite the existence of a large milk market and partially unmet milk demand. Similarly (Bebo 2003) had observed that the priority objectives for resource poor households was for their cattle to produce milk for feeding the family and then to have some marketable surplus while incurring minimal investment risks particularly related to feeding practices.

The findings however differ with those from (Mekonnen et al 2009) on a study on dairy technology adoption in smallholder farms in 'Dejen' district of Ethiopia who found that dairy technology adoption among smallholder dairy farmers was still low and proximity of the farm to market increased the adoption of dairy technologies. Thorpe et al (2000) had also noted that in Eastern Africa just as many parts of the tropics market availability played a key role in promotion of smallholder dairy farming making many smallholder dairy farmers concentrated near or within urban areas so as to easily access market. Lwelamira et al (2010) had also observed unreliable milk market, as the major challenge to small scale dairy farming in Karagwe district of Tanzania

The findings as compared to the reviewed literature therefore indicates that the various factors challenging adoption of dairy technologies need be established and addressed in any dairy production system where market availability fails to motivate technology adoption for enhanced production.

Labor availability and its influence on adoption of the four technologies under study were not significant. The findings differ with those of (Chipande 1983) who found labor deficiency and inappropriate innovation packages as the main constraints to innovations adoption in Malawi. Nicholson et al (1999) had also identified labor and household size as factors which influenced adoption of dairy technologies in Coast province. Mureithi et al (1998) while assessing the factors which influenced adoption of forages in smallholder dairy farms in the coastal lowlands of Kenya had also identified labor shortage as one of the factors which affected adoption of dairy technologies Jackline (2002) while in an integrated pest management adoption study in Uganda, found farm labor availability influential in adoption. Chipande (1983) reported labor deficiency and in appropriate innovation packages as the main constraints in innovation adoption among female headed households in Malawi. Mekonnen et al (2009) had also observed that the larger the family size the higher the adoption levels of dairy technologies..

The study had however reported labor as a challenge towards adoption of all the four technologies despite no relationship being observed between them. Since labor availability was defined by the household members doing dairy work and number of hired laborers the study was not able to get their labor outputs and that could have contributed towards showing no relationship. The labor levels might not have been

adequate to warrant adoption of the various technologies just as other factors could have challenged adoption despite the availability of labor. A standardized definition of labor availability is therefore necessary for meaningful comparison between dairy technologies adoption studies.

5.3: Conclusions

Market availability never influenced adoption of the dairy technologies under study. Average distance to milk market was 2.5 Kilometers indicating most farmers had no challenges in accessing market but that did not motivate them to adopt the technologies so as to enhance and sustain production. The average price of milk per liter at 0.4 US dollar was also favorable but only that the average production per cow per day at 4 liters was very low not even warranting the cow to be under zero grazing. Probable an increase in milk production could have motivated adoption. Long calving interval at 20 months across the three districts affected production. Breeding in dairy production thus continued pausing challenges to dairy farmers in Kenya.

Labor continued to be a challenge towards adoption of various agricultural technologies as out of the four technologies under study labor featured in all of them though at different strength. Another concern was that women were still the main workers in the dairy production since hired laborers were getting more costly and also not reliable making women to be always available to step in and fill any labor gap left in the household. Children who had previously been reported as key providers of labor in dairy work were now not major players. The gap created by the children also got filled by the women thus it becomes disheartening when a woman sacrifices to keep a cow under zero grazing when the calving interval is 20 months or average milk production remains at 3 liters per day despite all the effort. That level of production definitely did not entice farmers to struggle with zero grazing.

Women had started making key decisions in agricultural production as the main decision makers on the use of the proceeds from dairy in 60% of the households surveyed. The only challenge towards full realization of women's worth in planning for project implementation was inadequate consultation..

Inadequate technical knowhow still remained a stumbling block towards adoption of dairy technologies. Most farmers were still constrained with relevant skills on the technologies that are prerequisite to intensive dairy production. On the other hand the technical department charged with the responsibility of imparting the skills was also constrained in technical skills.

Intensive dairy production seems to be confining the women to the extent some have started dreaming of when the captivity was going to end. This shows the farmers have not been capacity built on diversification since some of them went into the project over ten years ago when they were relatively young and strong but were now aging.

Land ownership in the coast province continued to be a challenge as farmers were constrained in establishment of fodder which is necessary for intensive dairy production. This was brought by the fact that land subdivision was rarely done when the household head was still alive thus making investment decisions difficult.

Farming has continued being in the hands of the old people thus prospects of enhanced food security in the coastal region remaining dim. The average age in all the three districts was 52 years, an age bracket which definitely got challenged with labor intensive technologies.

There was no much difference in adoption of dairy technologies based on gender as most technologies were uniformly adopted at very low levels. However zero grazing was adopted at high levels by both men

and women only that the milk production levels were not commensurate with the effort the system required.

Kwale district was better in adoption of the four technologies compared with the other two districts. Malindi was poorer in adoption since hay baling and silage making had not been adopted and even Napier grass and zero grazing levels were lower compared to the other two districts.

Heifer International Kenya funded farmers were better adopters of both zero grazing and Napier grass establishment compared to individual farmers. However the deterioration of the zero grazing units threatened zero grazing even by the HIK supported groups.

The study confirmed the three adoption models highlighted earlier. Under *the innovation adoption model* where access to information was critical towards adoption of any technology, it was noted that most farmers lacked the necessary technological skills. This therefore hampered adoption

On *the economic constraint model* purporting that inadequacy in resources challenged adoption, was also confirmed by farmers having been unable to adopt some technologies because of cost for inputs or hiring labor.

The *adopter perception paradigm* was also confirmed where farmers left some of the advocated technologies and went for alternatives they found workable. For example, instead of making silage or hay farmers relied on natural pasture to cut down costs. Also due to labor challenges farmers opted for semi intensive dairy production systems.

5.4: Recommendations of the study.

To enhance fodder conservation both the staff and the farmers need to be trained and exposed to practical fodder conservation skills.

Researchers and extension service providers need to re examine the compatibility of the various fodder varieties with the agro ecological zones, farming systems and resource base of the farmers

Cost benefit analysis of the different dairy production systems in various agro ecological zones or farming systems need to be evaluated so as to enable farmers make informed decisions on the technologies they adopt. This would also be able to form a basis of advice to various development partners who support farmers on the basis of uniform production system across the country.

Policies developed should be able to ensure smallholder dairy farmers were in a position to access affordable and reliable dairy cattle breeding services so as to avoid long calving intervals.

With dairy farming remaining in the hands of the old people which remains a worrying trend towards food security, it is necessary that measures be put in place to entice the youth to also go into dairy farming.

5.5: Recommendations for further study.

Similar studies should be conducted using longitudinal designs so as to determine changes over time since the current study was based on a cross sectional survey design,

The current study focused on the coastal lowland smallholder dairy farmers therefore a similar study should be conducted to cover other smallholder dairy farmers in the other parts of the country.

Other studies focusing on adoption of dairy cattle feeding technologies in the coast province more so focusing on both the quality and quantity provided versus the requirements of the cows need to be conducted.

There is need for a study to be conducted on the main factors influencing the long calving intervals in dairy cows in Coast province.

A study on gross margin analysis of smallholder dairy farming in the various agro-ecological zones of the province and country would be able to assist farmers in making informed choices. .

With labor becoming both expensive and unavailable there is need for a study on dairy production labor sources, challenges and future prospects.

More research on effect of income levels on adoption of dairy technologies also necessary to be conducted.

References

Baltenweck, I. (2000). *Adoption of grade cattle technology in Kenya: a combined farm level and spatial approach. PhD Thesis*. Université d'Auvergne -

Baltenweck, I. (2010) *Competitiveness of smallholder dairy farmers in East Africa.* Presentation at the 6th African Dairy Conference & Exhibition, Kigali, Rwanda May 19-21, 2010. Nairobi (Kenya): ILRI

Bebe, B.O., (2003). *Herd Dynamics of Small Holder Dairy in the Kenya Highlands*. PhD Thesis Wagenigen University, the Netherlands .

Chipande, C.H.R.(1987) Innovation adoption among female headed households. The case of Malawi. and change (SAGE ,London, Newbary park, Beverly Hills and New Deltic) Vol. 18 Development (1987) 315-327

Director of Livestock Production (2009), *Annual Animal Production report for 2008 Nairobi, Kenya.*

District Development Officer, Kwale District (2009). *District Development Plan for Kwale District 2008*.

District Development Officer Kilifi District, (2009). District Development Plan for Kilifi District 2008

District Development Officer, Malindi District (2009). *District Development Plan fo Malindi District 2008.*

District Livestock Production Officers, Coast Province. (1998 to 2008). *Annual Livestock Production reports for 1998 to 2008.* Coast Province, Kenya.

Doss, C.R., (2003) *Understanding farm level Technology Adoption*; *Lessons learnt from CIMMYT'S Microsurveys in Eastern Africa*. CIMMYT Economics Working paper 03-07. Mexico, D.F:CIMMYT.

Doss, C.R., (2006) *Analyzing Technology Adoption, Challenges and limitations of micro studies.* New Haven, CT 06520-8206,USA. Agricultural Economics 34 (2006) 207–219

FAO (2010) *World report on milk production and population for 2010*.

Feder G., Just R.E. and Zilberman D.(1985). Adoption of agricultural in developing countries : a survey, *Economic Development and* innovations *Cultural Change*, vol. 33, 2, pp.255-298

Heifer Project International, Kenya Coast Region.(2009) *Annual report for July 2007-June 2008 for the Coast Region,* Kenya.

Hemme T, Christoffers K and Deeken E (2004) IFCN dairy report 2004 :for a better understanding of milk production world-wide. Braunschweig Global Farm GbR, 152p :

Jackline, B.W. (2002). *Assessing factors affecting Adoption of Agricultural Technologies The case of integrated pest management in Kumi District, Eastern Uganda.* A Masters of Science Thesis.Virginia Polytechnic and state university .

Kenya Agricultural Research Institute, Coast Region(2008) Annual report of 2007

Langyintuo, A. and Mulugetta, M. (2005). *Modeling Agricultural technology Adoption using the soft ware STATA*. CIMMYT-ALP Training manual No. 1/2005 (PART TWO)

Langyintuo, A. S. and Mullugetta, M. (2005). *Accounting for neighborhood influence in estimating factors determining the adoption of improved agricultural technologies*. Paper presented at the American Agricultural economics association Annual meeting, providence, Rhode Island, July 24-27 2005

Liu J.X., Wu Y.M. and Zhou Z.E. (2002*). Current situation and prospect for dairy production in China*

Lwelamira, J., Binamungu, H. K and Njau, F. B (2010) Contribution of small scale dairy farming under zero-grazing in improving household welfare in Kayanga ward Karagwe District, Tanzania

Institute of rural development planning, P.O.Box 138,Dodoma, Tanzania Karagwe District council, P.O.Box,22, Kagera, Tanzania

Maarse L.M., (1995). *A gender differentiated study on impacts of intensive dairy farming on socio-economic position of small holder households in Kiambu, Meru, Migori, Nandi and Vihiga District,* Kenya .

Mahajan, V., Muller, E. and Bass, F.M. (1990) New product diffusion models in marketing: A review and directions for research. *Journal of Marketing,* **54**: 1-26.

Makokha, S. N (2005) Analysis of factors influencing the adoption of Dairy technologies in Western Kenya. PhD thesis,Department of Agricultural Economics, University of Nairobi.

Makokha, S.N., karugia J., Staal, S. and Kasura, O. (2008) *Adoption of dairy technologies; Lessons learned from case study in western Kenya* .

Mekonnen, H., Dehninet, G., Kelay B., (2009). *Dairy technology adoption in small holder farms in 'Dejen' District, Ethiopia*. Published online 9/8/09 @ springer science +Business media.

Ministry of Agriculture and Ministry of Livestock and Fisheries Development (2004) Strategy for Revitalizing Agriculture 2004-2014

Ministry of Livestock Development (1990). *The role of women in the National Dairy Development programme* . Kenya

Ministry of Livestock Development (2008) *National Livestock policy*. Sessional paper No.2 of 2008.

Mugenda, O. M and Mugenda, A. G (2003) Research Methods; Quantitative and Qualitative Approaches.African Centre for Technology Studies(acts)

Mukolwe, M. M., Kamau, B, Nguithi., M,. Coenraads. and M, A. Oomen-myin (1990). J*oint evaluation National Dairy development project phase iv.*

Mureithi, J. G., Njunie, M.N., Muinga, R.W., R, Ali., Thorpe, W. and Mwatate, C.D., (1998). *Adoption of planted forages by small holder dairy farmers in coastal lowland Kenya Tropical grasslands* (1998) volume 32, 221-229.

Mwangi, D.M. and Wambugu, C. (2003). *Adoption of forage legumes, the case of desmodium intortum and calliandra calothyrsus in central Kenya*. Tropical grasslands (2003) volume 37,227-238 .

Nakamanee G (1999) Successful smallholder silage production: a case study from northeast Thailand Pakchong Animal Nutrition Research Centre Thailand

National Dairy Development programme (1992). *Annual seminar "Household dynamics in zero grazing"*. The implication of gender on extension

Nicholson, C.F., Thornton, P.K., Mohammed, L., Muinga, R.W., Mwamachi, D.M., Elbasha, E.H., Staa,l S.J. and Thorpe, W. (1999). *Smallholder Dairy Technology in Coastal Kenya.* An adoption and impact study. ILRI (International Livestock Research Institute), Nairobi, Kenya. 68 pp.

Njwe R M (1984) Provision of adequate animal protein to the Cameroon population by 2000 AD. Problems and prospects, Cameroon Dschang University Centre Cameroon .

Norris, P.E.and Batie, S.S. (1987). Virginia farmers' soil conservation decisions: An application of Tobit analysis. Southern Journal of Agricultural Economics 19(1): 79-89

Orodho, A.B. (2006). *The role and importance of Napier grass in the small holder dairy industry in Kenya*

Osuji P.O. (1974). The physiology of eating and the energy expenditure of the ruminant at pasture. *Journal of Range management* 27(6):437–443

Patel ,I. (2001) A case study on adoption of urea molasses mineral blocks. Professor, Institute of Rural Management, Anand 388001, India

Provincial Director of Agriculture, Coast Province (2009). *Annual Agricultural Production, Report for 2008, Coast Province*.

Provincial Director of Livestock Production, Coast Province (2009), *Annual Livestock Production report for 2008. For Coast Province*, Kenya.

Redda T (2001) Small-scale milk marketing and processing in Ethiopia Ministry of Agriculture, P.O. Box 3431, Addis Ababa, Ethiopia

Staal, S. J., Chege, L., Kenyanjui, M., Kimari, A, Lukuyu, B., Njubi, D., Owango, M., Tanner J., Thorpe, W and Wambugu, M. (1997) Characterization of Dairy Systems Supplying the Nairobi Milk Market; A Pilot Survey in Kiambu District.Identification of Target Groups of Producers. KARI/MOA/ILRI Collaborative Research Project Report

Shampine, A. 1998. Compensating for information externalities in technology diffusion models.*Amer. J. of Agric. Econ*. 80(3): 337-346

Smale, M., Just, R., Leathers, H. D. (1994). Land Allocation in HYV Adoption Models: An Investigation of Alternative Explanations. *Amer. J. of Agric. Econ*. 76(3): 5346

Staal S. J and Kaguongo, W. N., (2003) The Uganda Dairy Sub-Sector; Targeting Development Opportunities. Report prepared for IFPRI and USAID Uganda .

Thorpe, W., Muriuki, H.G., Omore, A., Owango, M.O., and Staal, S., (2000). *Dairy Development in Kenya the past, the present and the future* paper prepared for the annual symposium of the animal production society of Kenya, March 22nd – 23rd 2000 KARI headquarters, Nairobi.

Vu, D.D and Cai D.V (2001) Dairy Research and Training Centre, Institute of Agricultural Science of South Vietnam 121 Nguyen Binh Khiem, District I, Ho Chi Minh City, Vietnam

Waithaka, M.M., Nyangaga, J. N., Staal, S. J., Wokabi, A.W., Njubi, D., Muriuki, K. G., Njoroge, L. N and Wanjohi, P.N. (2002) Characterization of Dairy systems in the Western Kenya Region; Report of Dairy and Crop Characterization activities in

Western Kenya.

Wambugu, M.N., (2004). *Extension and its effect on dairy cattle nutrition and productivity in small holder dairy enterprises in Kiambu District*. A masters of Science thesis, university of Nairobi

Wekesa, E., Mwangi, W., Verkuijl, H., Danda, K. and De Groote, H. (2003). *Adoption o maize production technologies in the coastal lowlands of Kenya.* Mexico, D.F CIMMYT.:

Appendices

Appendix 1 Field questionnaires

Field questionnaire for farmers

Farm code [----------]

1	Date of interview	
2	District	
3	Name of group	
4	Project financier	HIK/ SELF

Demographics

6	Name	
7	Sub tribe	Giriama /Chonyi /Digo
8	Sex	
9	Age	
10	Education level attained	
11	Number of House hold members assisting in dairy work	
12	Number of hired laborers for dairy	
13	Main dairy worker in the farm	

Farm activities

14	What is the average off dairy income per month? Kshs	
15	Farm size owned in acres	
16	Land ownership status	
17	Highest Napier acreage ever had.	
18	Total number of fodder trees owned	
19	Highest number of fodder trees ever had	
20	Acreage of herbaceous legumes	
21	Highest number of herbaceous legumes ever had	
22	Main challenge to Napier grass establishment	
23	Main challenge to fodder trees establishment	
24	Main challenge to herbaceous legumes establishment	

25 How many cattle do you have presently?

Type	Dairy cross**[1]**	Beef **[2]**	Total**[3]**
Tows			
Heifers			
Calves			
Steers			
Bulls			
Total			

26	How many cows are in milk?	
27	Total amount of milk produced by all cows?	
28	Average amount of milk produced by each cow per day?	
29	What is the selling price of milk per liter?	
30	What is the distance to your main milk market?	
31	What is your main challenge in milk marketing?	
32	What is the calving interval of your cows?	
33	How cows have died in the last three years?	
34	What was/were the main causes of death?	

Technical services available.

35.	What is the distance to your source of extension services?	
36	What is the distance to your main source of dairy production inputs?	

Information on feeding

37	How many months in a year are your cows under zero grazing?	
38	What are the challenges of Zero grazing?	
39	Do you currently have mineral supplements for your cattle?	
40	If not why?	

Information on fodder conservation

41	How times have you ever made silage?	
42	What is the main challenge to Silage making?	
43	How times have you ever baled Hay since you started dairy farming?	
44	What are the challenges in Hay baling?	

Field questionnaire for District Livestock Production Officers and Heifer International Kenya.

1		Kilifi	Kwale	Malindi	HIK Coast	PDLP Coast
	Number of staff					
	Practically competent on pit Silage making technique					
	Practically competent in other silage making techniques					
	Practically competent on one hay baling technique					
	Practically competent on more than one hay baling technique.					

2	What are the main challenges in Herbaceous legumes establishment?	
3	How do you think they could be overcome?	

4	What are the main challenges in Napier grass establishment?	
5	How do you think they could be overcome?	

6	What are the main challenges in silage making?	
7	How do you think they could be overcome?	

8	What are the main challenges in hay Baling?	
9	How do you think they could be overcome?	

10	What are the main challenges in zero grazing?	
11	How do you think they could be overcome?	

12	What are the main challenges in Fodder trees establishment?	
13	How do you think they could be overcome?	

14	What are the main challenges in Milk marketing?	
15	How do you think they could be overcome?	

Appendix 2 Study findings

Table 4.1: Summary of descriptive statistics of continuous variables by district

Variable	Kwale		Kilifi		Malindi	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Age in years	50.13	13.41	56.52	9.448	50.13	13.41
Highest education level	9.32	5.328	6.81	5.446	4.83	4.86
Number of household members doing dairy work	2.8	1.871	1.48	0.602	4.42	3.035
Number of dairy laborers	0.4	0.5	0.43	0.507	0.17	0.381
Acres of land owned by farmer	3.64	3.108	6.559	4.663	7.198	4.502
Highest Napier acreage	0.766	0.407	0.631	0.472	0.833	0.633
Highest number of fodder trees	128.04	214.7	83.57	100.8	53.67	80
Highest acreage of herbaceous legumes attained	0.066	0.094	0.069	0.131	0.146	0.324
Total dairy cows owned	1.92	1.187	295	2.765	2.79	2.265
Liters of milk per cow per day	3.12	4.585	4.95	3.471	4.12	4.174
Highest amount of milk in liters per day best cow has produced	14.16	4.939	12.62	4.177	10.54	4.128
Average Calving interval in months	20.68	3.338	20.38	7.612	19.08	7.424
Number of cows dead in last three years	1.24	0.831	1.19	0.981	1.29	1.233
Distance in Kilometers to source of inputs	11.12	10.09	9.095	10.91	3.646	4.129
Distance in Kilometers to source of extension services	4	5.139	4.205	4.303	2.5	1.713
Kilometers to main milk market	3.44	5.738	2.643	3.167	1.333	2.665

Table 4.2: Summary statistics of continuous variables by sex.

Variable	Total(N=70)		Females (n=43)		Males(n=27)	
	Mean	Std Dev	Mean	Std Dev	Mean	Std Dev
Age in years	52.1	11.83	51.21	10.4	53.41	13.913
Highest education level	7.03	5.299	6	5.385	8.67	5.299
Number of household members doing dairy work	2.96	2.41	3.21	2.739	2.56	1.739
Number of dairy laborers	0.33	0.473	0.3	0.465	0.37	0.492
Acres of land owned by farmer	5.74	4.354	4.349	3.493	7.944	4.728
Highest Napier acreage	0.75	0.512	0.75	0.405	0.746	0.657
Highest number of fodder trees	89.2	148.67	82.63	132.1	99.67	174.04
Highest acreage of herbaceous legumes attained	0.01	0.054	0.077	0.131	0.009	0.0811
Total dairy cows owned	2.53	2.152	2.09	1.231	3.22	3.004
Liters of milk per cow per day	4.01	4.144	3.37	3.723	5.04	4.628
Highest milk in liters per day best cow has produced	12.5	4.643	12.3	4.329	12.7	5.18
Average Calving interval in months	20	6.289	19.91	5.107	20.26	7.921
Number of cows dead in last three years	1.24	1.013	1.16	0.974	1.37	1.079
Distance in kilometers to source of inputs	7.95	9.2795	9.407	9.876	5.629	7.865
Distance in kilometers to source of extension services	3.55	4.015	2.763	2.697	4.796	5.328
Distance in kilometers to main milk market	2.48	4.186	2.837	4.434	1.907	3.767

Table 4.3: Zero grazing challenges in Coast province, Kenya by district.

District	Unreliable and erratic rainfall	Inadequate labor	Unreliable milk market	Silent heat by cows	Expensive	Livestock diseases
Kwale	1%	26%	0%	0%	3%	0%
Kilifi	0%	26%	1%	8%	0%	0%
Malindi	4%	30%	0%	0%	0%	1%
Total	5%	82%	1%	8%	3%	1%

Table 4.4: Zero grazing challenges in Coast province, Kenya by sex.

Sex	Unreliable and erratic rainfall	Inadequate labor	Unreliable milk market	Silent heat by cows	Expensive	Livestock diseases
Male	3%	32%	0%	3%	1%	0%
Female	3%	50%	1%	5%	1%	1%
Total	6%	82%	1%	7%	2%	1%

Table 4.5: Correlation of factors influencing adoption of Zero grazing in Coast province, Kenya.

Variable	Total sample	Pearson's correlation coefficient	Significance (1 tailed)
Kilometers to milk market	70	0.183	0.065
House hold members in dairy work	70	-0.216	0.036
Number of hired laborers	70	0.087	0.238

Dependent variable is Zero grazing months per year.

Table 4.6: Napier grass establishment challenges in Coast province, Kenya, by district.

District	Unreliable and erratic rainfall	Inadequate labor	Inadequate technical knowhow	Inadequate planting material	Land ownership problems	Uncontrolled grazing of Napier grass by neighbors livestock	natural pasture readily available	other specify
Kwale	10%	6%	0%	6%	0%	3%	3%	3%
Kilifi	19%	6%	1%	1%	4%	1%	0%	1%
Malindi	10%	4%	0%	0%	0%	16%	6%	0%
Total	39%	16	1%	7%	4%	20%	9%	4%

Table 4.7: Napier grass establishment chalenges in Coast province, Kenya, by sex.

Sex	unreliable and erratic rainfall	inadequate labor	inadequate technical knowhow	inadequate planting material	land ownership problems	Uncontrolled grazing of Napier grass by neighbors livestock	natural pasture readily available	other specify
Male	16%	4%	1%	1%	1%	12%	3%	0%
Female	23%	12%	0%	6%	3%	8%	6%	4%
Total	39%	16%	1%	7%	4%	20%	9%	4%

Table 4.8: Correlation of factors influencing adoption of Napier grass establishment in Coast province, Kenya.

Variable	Total sample	Pearson's correlation coefficient	Significance (1 tailed)
Kilometers to milk market	70	-0.007	0.478
House hold members in dairy work	70	-0.068	0.288
Number of hired laborers	70	0.123	0.154

Dependent variable is Napier grass acreage

Table 4.9: Silage making constraints in Coast province, Kenya by district.

District	High cost of ensiling material	Inadequate labor	Inadequate technical knowhow	Inadequate fodder	High availability of natural pasture
Kwale	0%	0%	1%	27%	1%
Kilifi	1%	1%	5%	27%	0%
Malindi	0%	3%	5%	23%	6%
Total	1%	4%	11%	77%	7%

Table 4.10: Silage making constraints in Coast province, Kenya by sex.

Sex	High cost of ensiling material	Inadequate labor	Inadequate technical knowhow	Inadequate fodder	High availability of natural pasture
Male	1%	3%	7%	26%	1%
Female	0%	1%	3%	51%	7%
Total	1%	4%	10%	77%	8%

Table 4.11: Correlations of factors influencing adoption of silage making in Coast province, Kenya.

Variable	Total sample	Pearson's correlation coefficient	Significance (1 tailed)
Kilometers to milk market	70	-0.05	0.34
House hold members in dairy work	70	0.034	0.389
Number of hired laborers	70	0.07	0.282

Dependent variable is silage making

Table 4.12: Hay baling chalenges in Coast province, Kenya by district.

District	Inadequate labor	Inadequate technical know how	Inadequate pasture for baling	Availability of natural pasture	Inadequate storage facilities
Kwale	11%	16%	0%	3%	0%
Kilifi	17%	14%	1%	1%	0%
Malindi	6%	13%	0%	14%	4%
Total	34%	43%	1%	18%	4%

Table 4.13: Hay baling challenges in Coast province, Kenya by sex.

Sex	Inadequate labor	Inadequate technical know how	Inadequate pasture for baling	Availability of natural pasture	Inadequate storage facilities
Male	11%	19%	0%	8%	1%
Female	23%	24%	1%	10%	3%
Total	34%	43%	1%	18%	4%

Table 4.14: Correlations of factors influencing adoption of hay baling in Coast province, Kenya.

Variable	Total sample	Pearson's correlation coefficient	Significance (1 tailed)
Kilometers to milk market	70	0.01	0.466
House hold members in dairy work	70	0.115	0.172
Number of hired laborers	70	0.056	0.322

Dependent variable is hay baling.