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# ADOPTION OF MODERN DAIRY TECHNOLOGIES AND ITS IMPACT ON MILK PRODUCTION IN NZAUI SUB-COUNTY, MAKUENI COUNTY

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***ABSTRACT***

*Dairy production is a biologically efficient system that converts large quantities of roughage in the tropics to milk. Milk production level is determined by the levels of technologies applied to the dairy enterprise. However, information on levels of adoption of dairy technologies especially in the arid and semi-arid areas (ASALs) of Kenya is scanty. This study thus sought to evaluate the extent of adoption of modern dairy technologies and its impact on milk production in Nzaui Sub-County of Makueni County, one of the ASAL counties in the country. The study was guided by the following specific objective: to assess effect of social economic characteristics of farmers to the level of adoption to modern dairy technologies; A cross-sectional descriptive survey design involving the use of questionnaires was used to collect relevant data from sampled households. The study showed that factors which influenced farmer rearing of improved animal types included gender (p=021), marital status. p=007), and income levels (p=000), with respect to fodder conservation technologies, the most important factors included marital status (p=032), training (p=030) and extension (p=026).The adoption of animal supplementation was influenced to a great extent by income levels (p=013), training (p=000) and occupation ( p=008) rather than household endogenic factors. In regards to milk yield, this was influenced to a great extent by marital status (p=050), land size (p=000), income (p=000) and training (p=000). This implied that farmers with larger farm sizes, more incomes and training access were better placed to achieve high milk yields than those with lesser of those characteristics. It was concluded that there is need for gender-specific interventions to enhance increased* *adoption of improved livestock technologies by farmers especially in regards to access to improved germplasm by all farmers. Access to improved livestock is the first step to enhancing milk yield, followed by other interventions. Other areas of interventions include enhanced access to training and awareness in improved livestock technologies, especially fodder conservations technologies.*

***Key words:*** *adoption; dairy; milk production; technologies*

# 1. INTRODUCTION

## 1.1 Background Information

Dairy production is a biologically efficient system that converts large quantities of roughage, the most abundant feed in the tropics to milk, the most nutritious food known to man. In areas where there is access to markets, dairying is preferred to meat production since it makes more efficient use of feed resources and provides a regular income to the producer (Walshe *et al*., 1991). It is more labour intensive and supports substantial employment in production, processing and marketing. Higher levels of production than those achieved in traditional tropical systems, whether from cattle, camels or small ruminants, often require the introduction of specialized dairy breeds and increased levels of inputs (nutrition and health care). It also requires a good linkage to markets for milk sales and inputs acquisition. Thus, the intensification of smallholder livestock systems through the adoption of dairy production is generally concentrated in areas with good infrastructure and close to major markets. Less intensive dairy production may also occur in other more distant areas (Walshe *et al*., 1991). These market factors, therefore, play a major part in determining the type of dairy production systems found in the tropics, and they are particularly important influences on smallholder dairy development.

Dairy industry in Kenya was first introduced by the Europeans settlers in the white highland at the beginning of 20$^{th}$ century and the Africans were not allowed to keep the dairy animals until late 1950s when the colonial policy paper Swynnerston Plan of 1954 was introduced, which allowed the African to engage in commercial agriculture (FAO, 2011). Exotic breeds were mainly imported from Europe and were placed in wet and cool temperate climate areas which were similar to the one they came from in Europe. These areas were close to the urban areas for ease of the marketing the milk produced from the dairy cattle.

Small dairy holders contribute up to 80% of the total marketed milk in Kenya and the dairy sector contributes up to the 3% GDP in Kenya and contributes about 365,000 in direct and indirect employment opportunities in Kenya. There are more than 60,000 small holder dairy farmers in the country and the dairy sector supports some 800,000 households generating an estimated 365,000 waged jobs in addition to the family labour involved (KARI, 2008).
Therefore, any small improvement of dairy productivity could create more employment opportunities in rural areas in a big way. This effect could be more pronounced in the transition zone ( Upper Midland -UM) with annual rainfall of between 750 to1000mm, where land holding sizes are more than in the traditional dairy areas of Upper Highland (UH) and lower Highland (LH) Agro ecological zones (AEZ) with annual rainfall of over 1000mm. Improvement of dairy in UH and LH is limited by small land holding sizes due intergenerational land subdivisions and therefore land kept aside for folder cultivation has been reducing with time.

Most of the small dairy farmers in Kenya are found in UM zones where there is potential for development and intensification as land holding sizes are larger and therefore land size kept aside for folder cultivation are higher. With adoption of modern technologies in fodder production, conservation, vaccination, concentrate feedings, deworming and improved breeds, such areas can be a new frontier in dairy intensification and commercialization (Staal, 2002) resulting in more jobs opportunities in rural areas.

High milk production can be achieved by adopting and implementing sound dairy technologies that have been developed by research institutions and universities. However, many research findings indicate that many dairy farmers are not using these new dairy technologies and rely on traditional animal husbandry that results in low milk production and productivities (Letha, 2013). This low production could be attributed to among others factors the presences of large number of small-scale dairy farmers who do not use the improved technologies and who dairy is only the secondary enterprise (Ahmed *et al.,* 2004).

Dairy enterprise productivities largely depend on the level of the farmer ability to adopt and implement the modern dairy technologies and this equally depends on social economic characteristics of that farmer (Wekesa, 2003). These characteristics include, level of education, exposure to dairy farming system, level of training on dairy husbandry, experience on dairy husbandry, exposure to information on dairy husbandry, farmer contact with extension agents, and knowledge on improved dairy technologies.

The technologies studied are adoption of improved breeds, modern breeding systems, use of concentrates, fodder production and fodder conservation methods. The research was designed to access how socioeconomic aspects of households affect adoption modern dairy technologies among smallholder dairy farmers in Nzaui Sub-County Makueni County. The study was being conducted to assess the effects of social economic characteristics of farmers on the level of adoption of modern dairy technologies in Nzaui Sub-County.

### 1.2 Objective of the Study

The objective of the study was to assess effect of social economic characteristics of farmers to the level of adoption to modern dairy technologies.

## 2. RESEARCH METHODOLOGY

### 2.1 The Study Area

The study area was located in Nzaui Sub-County in Makueni County in the former Eastern province of Kenya (Figure 2). The Sub-County consist of five administrative divisions namely; Mulala, Mbitini, Matiliku, Kalamba and Nguu and has sixteen (16) locations and sixty-seven (67) sub-locations. It has a population of 116,811 people and 24,562 households with an average farm size of 2.12 hectares with the total area of about 777.4Km$^2$. (Kenya census, 2009) The area is located about 160 km from Nairobi. It lays between the longitude 37$^0$ and 39$^0$ East and latitude 1$^0$ to 3$^0$ South. Most of the land is hilly terrain with some flat area in the division of Nguu. The climate of the area is sub-tropical and it receives an average rainfall of 500mm to 1000mm per annum and daily temperature ranges from 18$^o$C to 32$^0$C minimum and maximum, respectively. The rainfall is bimodal with long rains in March- May and the short rain in October-December; however, the short rains are more reliable than short rains.

### 2.2 Research Design

Research design can be described as the structure of research (Kothari, 1985; Robson 2002). It is the strategy, plan, and the structure of conducting research. Research design was used to structure the research, to show how all the major parts of the research project were fitted together. A descriptive survey design was used. Descriptive research design is a scientific method which involves observing and describing the behaviour of a subject without influencing it in any way. Descriptive research does not fit neatly into the definition of either quantitative or qualitative research methodologies, but instead it can utilize elements of both, often within the same study. For this survey, both approaches were used. A survey obtains information from a sample of people by means of self-report, that is, people responds to a series of questions posed by an investigator (Kothari, 1985). In this study, a descriptive survey design was preferred because it provided a general account of the characteristics of respondents, for example behaviour, opinion and knowledge of a particular situation.

Descriptive research involves gathering data that describe events and then organizes, tabulates, depicts, and describes the data collection (Hopkins *at el.,* 1984).Frequencies were used to aid in understanding the data distribution.

**2.3 Sampling**

Livestock keepers were sampled from the sub-locations based on their climatic potential for dairy productions and their proximity to peri-urban centers. These urban centers provide reliable markets for dairy products. Sampling was done in Matiliku sub-location of Nzaui location, Ndovea and Kawala sub-locations of Kawala locations. Based on secondary data from the Ministry of Livestock at the Sub-County level and other key informants mainly location chiefs, assistant chiefs in charge of sub locations and the village administrators, total number of livestock keepers identified were 2482, with Kawala 842, Ndovea 543 and Matiliku 897. More than 10% of sampled population representing 108, 88, and 110 respectively were randomly selected for study and the questionnaire were administered to them. According to Mugenda and Mugenda (2003), a test of significance can be performed for a sample of 10% of the total population.

**2.4 Method of Data Collection**

A pre-tested structured questionnaire was used to collect the relevant information through personal interview at the household of the respondents in the study area. The data collected included the socio-economic characteristics such as, age, formal education status, extension contacts, training on dairy farming, experience on dairy farming and knowledge level of the farmers regarding improved dairy technologies such as fodder production, fodder conservation method, supplementation, improved breeds, total land acreage, land acreage under folder, household income, off farm household income and the average milk production in the household. The constraints affecting the adoption of modern dairy technologies were identified, ranked and documented.

The primary data collected was qualitative and was coded and used to analyze the extent of adoption of modern dairy technologies of the farmers in the study area. To estimate the extent of adoption of the modern dairy technologies, five selected technologies mainly improved dairy breeds, breeding system, supplementation, fodder production and fodder conservation method were established and their adoption level computed as a percentage of farmers implementing each of them. From the data collected, the most important constraints limiting the adoption of modern dairy technologies were identified and ranked.

**2.5 Method of Data Analysis**

Statistical Package for Social Sciences (SPSS) computer package was used to analyze all the data collected. The data was analyzed thematically around issues related to the adoption of the different modern dairy technologies, milk production capacities, socioeconomic descriptions of the respondents in the study site and the constraints limiting adoption of these technologies in the study site.

**2.6 Regression model specifications**

Logit regressions was done to determine the factors that influenced animal types kept, fodder conservation technologies, use of animal supplementation and milk yield levels. The decision to utilize or not to utilize a particular livestock management model is a binary decision .Several socio-economic factors can determine the probability of a smallholder farmer 93egressio a given livestock intervention or not. The most popular models for estimating binary choice models include probit, logit and linear probability (Adesina and Baidu-Forson, 1995). In this study a logistic regression procedure using maximum likelihood estimation was used to estimate the

probability of livestock technologies being utilized (Kmenta, 1986). The technologies considered included animal type, fodder conservation, and animal supplementation. The estimated model is expressed as follows:
The "logit" is the natural log odds of the event, Y=1, that is,

logit [p] = ln [odds( Y=1)] = ln $\left[\frac{p}{1-p}\right]$

Where
P =probability of event occuring
Y=event
Ln= Natural logarithm

***Table 1: The variable selection table for the 3 logit 94egression models***

| **Variable** | **Type of measurement** | **Considerations** |
|---|---|---|
| ***Dependent variables*** | | |
| Animal type (Regression 1)-Logit | Dummy (1 if Exotic, 0 if local) | |
| Fodder conservation (Regression 2)-Logit | Dummy (1 if yes, 0 if no) | |
| Animal feed supplementation (Regression 3)-Logit | Dummy (1 if yes, 0 if no) | |
| Milk yield levels (Regression 4)-Logit | Dummy (1 if above 5 litres, 0 if below 5 litres) | |
| ***Independent variables*** | Dummy (1 if yes, 0 if no) | |
| Gender of the household head, | Binary ((1 if Male, 2 if Female)) | Gender differences likely to influence improved livestock technologies |
| Age of household head | Numeric (Years) | Older farmers less likely to adopt improved technologies than young farmers |
| Marital status of the household head | 1, Single, 2, Married | Married households likely to invest in improved livestock systems |
| Education level of household head | 1, None, 2, Primary, 3, Secondary, 4, Tertiary, 5, University | Education improves access to improved livestock technologies and their use |
| Main occupation of the household head | 1, Commercial, 0=subsistence | Farmers with commercial orientation will likely adopt improved livestock technologies than those with subsistence orientation |
| Income levels | Dummy (1 if N) | Farmers with higher incomes can adopt improved technologies than those with low incomes |
| Farm size | Numeric (Hectares) | Famers with larger farms are more flexible and can invest in improved livestock |

| | | |
|---|---|---|
| Access to extension | Dummy (1 if yes, 0 if no) | Access to extension enhances use of improved livestock technologies |
| Training on livestock technologies | Dummy (1 if yes, 0 if no) | Training enhances adoption of improved and specific technologies |

## 3. RESULTS

From the data collected, out of the 320 questionnaires administered to the households in Nzaui Sub-County, Makueni County, 306 questionnaires were filled and returned. This represented a 96% response rate, which is considered satisfactory to make conclusions for the study. According to Mugenda and Mugenda (2003) a 50% response rate is adequate, 60% good and above 70% rated very good. This also agrees with Bailey (2000) assertion that a response rate of 50% is adequate, while a response rate greater than 70% is very good. This implies that based on this assertion; the response rate which was calculated in this case was according to Mugenda and Mugenda and Bailey were very good.

### 3.1 Description of the socioeconomic characteristics in the study sites

The demographic data seeks to establish the general information of the respondents. From the questionnaire, the following profiles of the respondents were established: gender, age bracket, education levels, their land size, marital status, their milk sources, and occupation and income levels.

Majority of respondents in the study sites were male with male respondents being 77% while 23% represented females in the total sample, indicating that most of the house-holds were male-headed. Male respondents were 86% (Matiliku), 78% (Kawala) and 65% (Ndovea). Gender was significantly linked to site in the study area ($X^2$ = 11.8256, df=2, p = 0.003) (Table 2).

The age distribution of farmers showed that most farmers were between 35-50 years (56%) in all locations. In Matiliku, 67 farmers (61%) were 35-50 years old, and 36% of farmers were above 50 years old (Table 4.1). In Matiliku, 60% of farmers were 35-50 years, while in Kawala and Ndovea, this age-set comprised 50% and 56% of the sample respectively. The age distribution was not significantly linked to sites. (p = 0.557)

Respondents were categorised into for levels of education. Literacy is a critical component in accessing agricultural information and contributes significantly to the adoption of dairy technologies. In each of the study sites, over 50% of the respondents attained primary school education, about 30% attained secondary school education. While 5%, 13% and 9% of the respondents in Matiliku, Ndovea and Kawala respectively did not attain any level of schooling. There were significant associations between education and study sites. P= 0.001(Table 2). Respondents in each of the study sites were categorised into either married, single or widow.

Majority of the respondents in each of the study sites are married with Ndovea having the highest number of married respondents at 89% in Matiliku, 84% in Kawala and 83% in Ndovea. In relation to the marital status, 86% of respondents who were married and 11% being widowed in the total sample and about 4% of the respondents were single. There was no significance linkage between marital status and sites (Table 2).

Most of the farmers (53%) owned 2-5 acres of land, while 27% owned less than 2 acres. There were 20% of farmers with land areas above 5acres. There was no significant linkage between land ownership and sites (Table 2).

The study showed that most of the farmers derived milk from own livestock including cows (70%), and goats (4%) while 26% bought their milk. Matiliku had the highest proportion of farmers deriving milk from cows

(92%), followed by Ndovea (76%) and Kawala (44%). Milk sources and sites were significantly associated ($X^2$= 69.0578, df=8, p = 0.000) (Table 2).

Farming was identified as the main occupation with 46%, 70% and 66% of the respondents from Matiliku, Ndovea, and Kawala respectively. Farming or running any business comes second in each of the three study sites with Ndovea having the highest number of respondents at 22% and Matiliku the least at 7% respondents engaged in both farming and business. In total, there were 60% farmers, 14% farmers and businessmen, 14% casuals and 10% salaried respondents. Occupation and sites were significantly associated according to the chi-square test ($X^2$ = 46.8920, df =8, p = 0.000)

Majority of the respondents in each of the study sites earned incomes of less than Ksh. 6000 per month (47%), 6000-12000 (37%). Matiliku leads with 84%, Ndovea 78% and Kawala 77% of the respondents with income level of below Ksh.12000 per month. There was a significant linkage between income levels and sites ($X^2$=46.076, df = 4, p = 0.000) (Table 2).

***Table 2: Respondents socio-demographic characteristics and site***

| | **Matiliku (110)** | **Kawala (108)** | **Ndovea (88)** | **Total** | **Chi-square** |
|---|---|---|---|---|---|
| **Gender** | | | | | |
| ***Male*** | 94(85.5) | 84(77.8) | 57(64.8) | 235(76.8) | $X^2$=11.826, df=2, P= $0.003^{xx}$ |
| ***Female*** | 16(14.5) | 24(22.2) | 31(35.2) | 71(23.2) | |
| **Age set** | | | | | |
| ***below 35yrs*** | 4(3.6) | 5(4.6) | 5(5.7) | 14(4.6) | X2=3.007, df=4, P = $0.557^{ns}$ |
| ***35yrs-50*** | 67(60.9) | 54(50.0) | 49(55.7) | 170(55.6) | |
| ***above 50yrs*** | 39(35.5) | 49(45.4) | 34(38.6) | 122(39.9) | |
| **Education level** | | | | | |
| ***Secondary*** | 31(28.2) | 36(33.3) | 33(37.5) | 100(32.7) | $X^2$=22.6383, df=6, P = $0.001^{xx}$ |
| ***Primary*** | 61(55.5) | 57(52.8) | 45(51.1) | 163(53.3) | |
| ***Post-secondary*** | 13(11.8) | 1(0.9) | 1(1.1) | 15(4.9) | |
| ***None*** | 5(4.5) | 14(13.0) | 9(10.2) | 28(9.2) | |
| **Marital status** | | | | | |
| ***Married*** | 98(89.1) | 91(84.3) | 73(83.0) | 262(85.6) | $X^2$ = 5.283, df=4, p = $0.259^{ns}$ |
| ***Widow*** | 7(6.4) | 15(13.9) | 10(11.4) | 32(10.5) | |
| ***Single*** | 5(4.5) | 2(1.9) | 5(5.7) | 12(3.9) | |
| **Land size categories** | | | | | |
| ***less than2*** | 37(33.6) | 30(27.8) | 16(18.2) | 83(27.1) | $X^2$ = 6.132, df=4, p= $0.190^{ns}$ |
| ***2-5 acres*** | 52(47.3) | 58(53.7) | 52(59.1) | 162(52.9) | |
| ***above 5 acres*** | 21(19.1) | 20(18.5) | 20(22.7) | 61(19.9) | |

| | | | | | |
|---|---|---|---|---|---|
| **Milk source** | | | | | |
| ***Cow*** | 101(91.8) | 47(43.5) | 67(76.1) | 215(70.3) | $X^2$ = 69.058, df=8 P= 0.000xxx |
| ***Buy*** | 5(4.5) | 55(50.9) | 18(20.5) | 78(25.5) | |
| ***Sheep*** | 1(0.9) | (0.0) | (0.0) | 1(0.3) | |
| ***Goat*** | 3(2.7) | 6(5.6) | 3(3.4) | 12(3.9) | |
| **Occupation** | | | | | |
| ***Farmer and business*** | 8(7.3) | 15(13.9) | 20(22.7) | 43(14.1) | $X^2$ = 46.8920, df=8, p = 0.000xxx |
| ***Casual*** | 28(25.5) | 10(9.3) | 5(5.7) | 43(14.1) | |
| ***Farmer*** | 50(45.5) | 76(70.4) | 58(65.9) | 184(60.1) | |
| ***Business*** | 3(2.7) | 2(1.9) | (0.0) | 5(1.6) | |
| ***Salaried*** | 21(19.1) | 5(4.6) | 5(5.7) | 31(10.1) | |
| **Income levels** | | | | | |
| ***above 12000*** | 21(19.1) | 9(8.3) | 24(27.3) | 54(17.6) | $X^2$)=46.076, df=4, p = 0.000xxxx |
| ***below 6000*** | 30(27.3) | 74(68.5) | 39(44.3) | 143(46.7) | |
| ***6000-12000*** | 59(53.6) | 25(23.1) | 25(28.4) | 109(35.6) | |
| *Note xxx significant at 1%.xx significant at 5% x significant at 10% ,ns –not significant* | | | | | |

### 3.2 Social Economic Factors influencing livestock technologies adoption

#### 3.2.1 Social economic Determinants of animal types kept in farms

The main factors that were significant in affecting whether farmers kept exotic livestock included gender, with male-headed farms more likely to keep exotic cows compared to female-headed farms. Marital status was significantly associated with keeping exotic livestock, because married families were associated more with exotic livestock than single house-holds as increasing the married level by 1 unit increases the odd of adopting exotic livestock by 0.473 times which is significant at 10% ( p=0.021). Increased household income by 1 level increased the odds of adopting exotic livestock 8.6 times which is significant at p=000 (Table 3).

#### 3.2.2 Social Economic Determinants of fodder conservation technologies

In terms of using fodder conservation technologies, married families were 0.0276 times more likely to keep exotic cows than single families( p=032). Increased training by one unit increases the odds of fodder conservation by 0.304 times while extension increases the odds of fodder conservation by 0.303 times (Table 4).

#### 3.2.3 Social Economic Determinants of use of animal supplementation

In regards to using animal supplementation, significant variables included age, occupation, income level, and training. The odds of using animal supplementation increased by 0.714 by increasing age by 1 level, while commercial occupations were associated with animal supplementation by a 0.121 increased likelihood. Increased income level by 1 level (more than 6000 Kshs/ month) increased odds of using animal supplementation technologies by 1.492 times, while training increased the odds of adopting feed supplementation by 0.055 times (Table 5).

The milk yield levels were found to be influenced by factors such as land size, marital status, income levels, and attendance to training. Marital status was associated with increased milk yield, with more married households likely to achieve more than 5 litres per day by 0.531 times more than single household. Farmers who had more land size by increased unit land sizes were likely to achieve more than 5 litres per day, 2.2 times more than farmers who had less land. An increment of incomes by more than Ksh 6000 per month, led to likelihood of higher milk yield up to more than 5 times likelihood. While training had a 0.3 times more likelihood of increasing milk yield (Table 6).

***Table 3: Social Economic Factors influencing animal types kept in farms***

| Variables | B | S.E. | Wald | Df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| Gender of head | -.749 | .325 | 5.331 | 1 | **.021** | .473 |
| Age | .412 | .283 | 2.116 | 1 | .146 | .662 |
| Education | .012 | .225 | .003 | 1 | .956 | 1.012 |
| Marital status | 1.006 | .374 | 7.216 | 1 | **.007** | .366 |
| Land size | .368 | .245 | 2.264 | 1 | .132 | 1.445 |
| Occupation | 1.581 | .738 | 4.593 | 1 | **.032** | 4.860 |
| Income level | 2.149 | .244 | 77.552 | 1 | **.000** | 8.577 |
| Training | -.262 | .343 | .583 | 1 | .445 | .770 |
| Extension | .678 | .523 | 1.682 | 1 | .195 | 1.971 |
| Constant | -5.606 | 1.553 | 13.029 | 1 | .000 | .004 |

*B- co-efficients SE- standard error wald-wald statistics Df - degree of freedom, sig-significant. Exp(B)- exponential of natural logs(odds)*

***Table 4: Social Economic Factors for fodder conservation technologies***

| Variables | B | S.E. | Wald | Df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| Gender of head | -.271 | .549 | .244 | 1 | 0.621 | .762 |
| Age | .320 | .380 | .707 | 1 | 0.400 | 1.377 |
| Education | -.267 | .366 | .532 | 1 | 0.466 | .766 |
| Marital status | 1.287 | .602 | 4.579 | 1 | **0.032** | .276 |
| Land size | .129 | .345 | .139 | 1 | 0.709 | 1.137 |
| Occupation | 1.888 | 1018.766 | .000 | 1 | 0.999 | 1.575E8 |
| Income level | -.422 | .285 | 2.198 | 1 | 0.138 | .655 |
| Training | 1.192 | .550 | 4.694 | 1 | **0.030** | .304 |
| Extension | -1.193 | .536 | 4.964 | 1 | **0.026** | .303 |
| Constant | -9.120 | 10187.666 | .000 | 1 | 0.999 | .000 |

*B- coefficients SE- standard error . wald-wald statistics.Df - degree of freedom, sig-significance Exp(B)- exponential of natural logs*

***Table 5: Social Economic Factors affecting feed supplementation technologies***

| Variables | B | S.E. | Wald | Df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| Gender of head | -.233 | .263 | .783 | 1 | 0.376 | .792 |
| Age | -.337 | .203 | 2.749 | 1 | 0.097 | .714 |
| Education | -.254 | .177 | 2.058 | 1 | 0.151 | .776 |
| Marital status | -.424 | .292 | 2.099 | 1 | 0.147 | .655 |
| Land size | .183 | .180 | 1.037 | 1 | 0.308 | 1.201 |
| Occupation | 2.111 | .795 | 7.048 | 1 | **0.008** | .121 |
| Income level | .400 | .161 | 6.187 | 1 | **0.013** | 1.492 |
| Training | 2.893 | .249 | 135.536 | 1 | **0.000** | .055 |
| Extension | -.008 | .361 | .000 | 1 | 0.983 | .992 |
| Constant | 8.652 | 1.472 | 34.541 | 1 | 0.000 | 5718.776 |

*B- co-efficients SE- standard error . wald-wald statistics.Df - degree of freedom, sig-significance Exp(B)- exponential of natural logs*

***Table 6: Social Economics Determinants of milk productivity levels***

| Variables | B | S.E. | Wald | Df | Sig. | Exp(B) |
|---|---|---|---|---|---|---|
| Gender of head | -.093 | .299 | .097 | 1 | 0.755 | .911 |
| Age | .086 | .244 | .124 | 1 | 0.725 | 1.090 |
| Education | -.038 | .200 | .036 | 1 | 0.850 | .963 |
| Marital status | -.632 | .332 | 3.634 | 1 | **0.050** | .531 |
| Land size | .780 | .222 | 12.382 | 1 | **0.000** | 2.182 |
| Occupation | -.486 | .885 | .302 | 1 | 0.583 | .615 |
| Income level | 1.643 | .182 | 81.365 | 1 | **0.000** | 5.170 |
| Training | 1.122 | .296 | 14.345 | 1 | **0.000** | .326 |
| Extension | .041 | .518 | .006 | 1 | 0.937 | 1.042 |
| Constant | -2.858 | 1.585 | 3.252 | 1 | 0.071 | .057 |

*B- co-efficients SE- standard error . wald-wald statistics.Df - degree of freedom, sig-significance Exp(B)- exponential of natural logs*

## 4. DISCUSSION, CONCLUSION AND RECOMMENDATION

The key socioeconomic characteristics that have a direct effect on the adoption of dairy technologies include education levels, land size, occupation, income levels, and gender.

Literacy is a critical component in accessing agricultural information and contributes significantly to the adoption of modern dairy technologies. In the study site, more than 80% of the respondents have attained primary schooling. However, relating this to adoption of the dairy technologies implies that farmers are constrained by some factors such as income, since majority of these farmers have income of less than Ksh 12000 per month which makes it impossible to meet cost of dairy breeds as well as other costs related to these the adoption of these technologies.

Farmers with more land acreage are more likely to adopt the modern dairy technologies. There is more adoption of fodder conservation in Matiliku than the other two study sites because most of the respondents have high income and more educated and there exposed to new technologies. This findings is in line with Kabunga (2008) who stated that, there is a positive association between farm size and adoption, implying that the likelihood of adoption is higher for farmers with more land. From the findings, majority were male respondents at 77% with 23% being female respondents. This implies there were more male-headed households than female ones in the entire study site. Some studies such as that by Kabunga (2014) reveal that female-headed households are more likely to adopt improved dairy cows. This could explain why there were low levels of adoption of dairy breeds in the study sites as majority of the households are headed by male. This was in contrast to Shibeshi (2017) findings that male households were more likely to adopt improved livestock technologies than female household.

Age is a critical component in determining whether the respondents were old enough to provide reliable insights relevant to the study. In the study site, 57% of the respondents were between 35-50 years and therefore old enough and thus could provide reliable information in arriving at these findings.

Income levels of the respondents in the study site constrained the adoption levels of the dairy technologies since majority of the respondents at 82% earned income of less than Ksh 12000 per month. Due to the cost implications in the adoption of this technology, low income earners have less adoption levels than the high-income earners. These views support those by Murithi (1990), that if the amount of resource use is increased, then there should be substantial increase in milk production. Although majority of the respondents in the study site at 60% were farmers, adoption of dairy breeds does not equate to this number of respondents meaning farming was mainly on non-dairy breeds.

Factors which influenced farmer rearing of improved animal types included; gender, marital status, and income levels. With respect to fodder conservation technologies, the most important factors included marital status (0.276, p=0.032) training (0.303, p=000 and extension (0.304, p=.030). The adoption of animal supplementation was influenced to a great extent by income levels (1.492, p=0.013) occupation (0.212, p = 0.008) rather than household endogenic factors. In regards to milk yield, this was influenced to a great extent by marital status (0,531, p=0.050), landsize (2.182, p=.000), income (5.170, p=.000) and training (.326, p=.000). This implied that a unit increase of these factors will increase the level of adoption of these technologies by indicated odds. And that farmers with larger farm sizes, more incomes and training access were better placed to achieve high milk yields than those with lesser of those characteristics.

The study concludes that in regards to animal type, household factors and resource availability were major factors which influence the type of animal to be kept by the households. Gender was a major factor which moderated the types of animals kept but not fodders conservation technologies, supplementation or milk yield levels. Fodder conservation was influenced by marital status, training and extension contact. This shows that training was important for farmers with respect to fodder conservation technologies. Milk yield was influenced by several factors including house-hold endogenic factors (marital status, income), farm factors (farm size), and external factors (training)

**Recommendations**

The study recommends that:

i. More awareness needs to be spread by the different actors to hasten the progress of adoption of dairy technologies especially with the prevailing social, ecological and economic conditions since uptake is still not to the desired levels.

ii. There is need for gender-specific interventions to enhance increased adoption of improved livestock technologies by farmers especially in regards to access to improved germplasm by all farmers.
iii. There is also need of ensuring wider access to credit facilities to farmers to help in improving their ability to purchase inputs required for modern dairy production.
iv. There needs to be enhanced access to training and awareness in improved livestock technologies, especially fodder conservation technologies.

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