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Farmers' Dairy Practices as a Constraint Facing Small-Scale Dairy Farmers in Cheborge in Kericho County, Kenya

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Abstract:
Achieving food security is part of the agenda of Sustainable Development Goals (SDGs). In Kenya, agriculture is the main source of livelihood particularly dairy farming among other agricultural practices. However, farming is a bit constrained by a number of factors leading to low milk production. This study was an enquiry into the socio-economic constraints facing small scale dairy farmers in Cheborge, Kericho County in Kenya. The study was guided by the sustainable livelihood framework. The study was dominantly qualitative and adopted a descriptive research design. A sample size of 109 farmers, representing 20% of the 545 households was selected using stratified sampling. Another ten key respondents were selected through purposive sampling, bringing the total number of respondents to 119. Data was collected through questionnaires and focused group discussion schedules. Quantitative data was analysed using descriptive statistics while qualitative data was analysed using content analysis. The study revealed that educated farmers have more productive farms which were attributed to their ability to adopt new agricultural technology. The study also found out that farming practices affect milk production to the extent that those who practice zero grazing produce more milk than those who practice open grazing. The study further revealed that access to loans had an effect in dairy production because those who had access invested in more superior dairy cows and implements like chaff cutters. It was therefore recommended that both illiterate and semi-illiterate farmers need to be engaged in informal dairy farming education forums by the local Dairy Boards. It was also recommended that farmers embrace modern farming methods for maximum production. Membership in a cooperative society was more beneficial to famers than non-membership. There is need for value addition on milk before it is sold to milk the milk processors. In this way, the farmers will get more value for their produce. It was further recommended that farmers join ROSCAS/SACCOS from where they could save and borrow money because majority of them could not access the traditional bank loans due to lack of collateral among other requirements. The study recommended that further studies be carried out to establish other possible causes of low milk production and to also investigate on the failure rate of Artificial Insemination technology.

Keywords: *Smallholder farmers, constraints, sustainable livelihoods*

1. Introduction

According to Jones, Comfort & Hillier, (2018) achieving food security is part of the agenda of the Sustainable Development Goals (SDGs). Particularly SDG 2 aim is to "End hunger, achieve food security and improve nutrition and promote sustainable agriculture". Despite significant advances in sustainable global agricultural production, food insecurity remains a key challenge due to the complex interaction between factors such as extreme weather patterns, rising levels of population and wealth, water scarcity, increases in energy costs and civil conflicts (McCarthy, Uysal, Melis, Mercier, Donnell, & Ktenioudaki, 2018 &Godfray et al., 2010).

Studies have shown that the globaldem and for milk has increased because of rapid population growth, urbanisation and shifts in dietary patterns (Bai, Lee,Ma, Ledgard, Oenema, Velth of, ... & Li, 2018 &Gerland et al., 2014). As such, to keep pace with the growth in demand, milk production needs to grow by close to 2 per cent per year (Hemme & Deeken, 2005). Globally 1.2 billion people are poor and an estimated 75 per cent of the world's poor live in rural areas (Aggarwal, 2018). The biomass of cattle in the world is observed by Phillips (2018) to be almost twice that of people and the largest of any animal on earth and that over a quarter of the cattle are dairy cows. Over 700 million of these people keep livestock according to Grace and McDermott (2011) to produce food, generate cash income, manage risks and build up assets (Milne, 2018). With the valuable contribution that livestock makes to sustain livelihoods especially in rural areas,

the development of small-scale livestock enterprises must be seen as a key element of any efforts to eradicate extreme poverty and hunger (Urassa, & Raphael, 2017 and OECD/FAO, 2016).

Global studies show that New Zealand dairy farms are largely operated by either owners or share milkers (LIC, 2008). Under the arrangement, the share milker owns the herd and plant, and is responsible for animal health and farm maintenance costs. The owner of the land, in turn, is responsible for infrastructure and capital expenditure. The New Zealand dairy industry has been shaped by two key government initiatives. The first initiative is the establishment of farmer-owned co-operative dairy manufacturing companies, a common feature of the dairy industry internationally and the second key initiative is the establishment of the Dairy Produce Control Board, (Dicken,2007). Fronterra co-operative group limited is New Zealand's largest company in terms of contribution to gross domestic product (GDP) and is classified as a TNC (Fonterra, 2008). It is the world's largest single exporter of dairy products and its supply chain extends from the farmers in New Zealand to customers in over 140 countries (Gray & Le Heron, 2012).

In South Asia, studies indicate that between 2003 and 2005, the region produced 123tonnes of milk or one -fifth of the global output (Parthasarathy, Rao& Birthal 2008). However, most of this production was concentrated in India (with a share of 74% of the milk output in South Asia and the world's largest producer of milk) and Pakistan which account for 23% of the South Asia's production. The Indian dairy market is expected to double within the next decade, primarily driven by over 15-20% growth in value added dairy segment. To leverage this high growth potential and to meet the rising demand, a sustainable and strong dairy farming base will be critical. To achieve this, it becomes critical to address key challenges faced by the industry such as, low animal yields, ineffective breeding, improper feed and fodder management, deficient veterinary care, poor farm management practices and low financial inclusion (Hemme, et al., 2005).

In Africa, most milk produced by smallholder dairy farmers comes from the following production systems: Rural smallholder dairying where dairy farming is often part of a mixed farming system in which manure is used for cash crop production (FAO, 2018). Dairy animals are fed on grass, crop residues and cultivated fodder and supplementary feeding is practised only when feasible. They also have Pastoral/agro-pastoral dairying which is island-based and milk is often the most important subsistence item. Nomadic pastoralists practise little or no agriculture and roam the land in search of grazing grounds and water. Lastly, they have Landless peri-urban dairying**.** This is a purely market-oriented production system located within and close to the boundaries of cities. Peri-urban dairy producers benefit from their proximity to markets, but their production is based on purchased inputs and may encounter problems of feed supply and waste disposal (FAO, 2018). Despite the significant livestock contribution to households' nutrition and incomes in many African smallholder farms, milk productivity remains low. Inadequate feeding is the main reason for the underperformance (Mwendia et al., 2018).

Regionally, Eastern Africa, is the leading milk producing region in Africa, representing 68% of the continent's milk output. Ethiopia, Kenya and Tanzania are among the biggest dairy producers in Africa. The dairy sector is one of the fastest growing agricultural sub-sectors in the region, generating significant economic returns and opportunities along dairy value chains (FAO, 2011). Milk demand in East Africa, is further projected to increase by 43% in 2050 over the 2005/2007 base (Pica-Ciamarra et al. 2014).

Studies show that Ethiopia dairy production depends mainly on indigenous livestock genetic resources; more specifically on cattle, goats, camels and sheep. Cattle has the largest contribution (81.2%) of the total national annual milk output, followed by goats (7.9%), camels (6.3%) and sheep (4.6%) (*CSA 2009).* Despite its potential for dairy development, productivity of indigenous livestock genetic resources in general is low, and its direct contribution to the national economy is limited. Further, the annual rate of increase in milk yield (estimated to be 1.2%) lags behind the increment in human population (estimated to be about 2.7% per annum) (CSA, 2008), and this resulted in large supply–demand variance for fresh milk (MoARD,2004). It is estimated that if the current level of milk production would be maintained, then about 6 million tonnes of additional milk (4% increment in total milk production) is required per annum to feed the increasing human population and narrow the gap in milk supply and demand (Azage, 2003). Thus, the country has been spending foreign currency to import dairy products from abroad to meet domestic demand. For instance, the country spent about 9.3 million USD in 2008(Haile,2009).

Agriculture is the main source of livelihoods of most people in Kenya and the dairy industry is the single largest agricultural sub-sector in Kenya dominated by smallholder (Omore, Muriuki, Kenyanjui, Owango, & Staal, (1999). The sector contributes 14% of the agricultural GDP and 3.5% of the national GDP (GOK, 2008). This makes it a significant sector whose growth and development is of national importance. The industry has undergone different political courses. In the pre-independence period, European settlers brought with them the practice of dairy cattle breeding and took over most of the agricultural land in Kenya in order to perform large-scale farming for export, supported by the colonial administration. The dairy farmers operate a mixed farming system (Moll, Staal, & Ibrahim, 2007). Following reductions in dairy prices as a result of First World War depression, many dairy operators merged into big corporations like the Kenya Co-operative Creameries (KCC), which was established in 1925. The KCC was created to market and process milk products, thereby supporting the settlers' dairy production (Atieno & Kanyinga, 2008). In 1954, the Swynnerton Plan was released, giving indigenous Kenyans the right to obtain commercial farming (Muriuki, Omore, Hooton, Waithaka, Ouma, Staal, & Odhiambo, 2003). Consequently, the indigenous people started participating in small scale commercial farming where Production was based on the close integration of dairy cattle into the mainly maize-based farms, with 71% of farmers keeping one to three cattle (Bebe et al 2003; Mugambi et al 2015) and is sometimes accompanied by cash crops such as coffee, tea, or pyrethrum. The cattle are usually Friesian or Ayrshire or their crosses.The cooperative membership helps farmers strengthen have strong bargaining powers in marketing their products and may increase milk production (Mugambi, Maina, Kairu & Gitunu, 2015).

In 1958, the KCC became the dominant agent in marketing for the dairy farmers and in the same year, the Kenya Dairy Board (KDB), a state corporation was established through an Act of Parliament, to regulate the market among other functions (Kanyinga, 2008). By 1980's KCC could no longer serve farmers adequately due to poor management and when it eventually collapsed, the sector was liberalized and other processors moved in to fill the gap in 1992. Liberalization led to a rapid growth of private processors and the informal milk trade that mainly consisted of small-scale operators. According to the industry statistics by the Kenya Dairy Board, in 2010, there were an estimated 27 processors, 64 mini dairies, 78 cottage industries and 1138 milk bars (Kanyinga, 2008). Prior to policy change in 2004, informal vendors (mobile milk traders, bar vendors, transporters) were not officially recognized and were frequently harassed, as powerful milk players sought to protect their interests and share. However, since 2004, there has been a major change in policy and practice towards the informal milk market (Leksmono et al.,2006). The Dairy Policy now clearly acknowledges the role of small-scale milk vendors (SSMVs) and contains specific measures to support them which include training on safe milk handling (Leksmono et al, 2006). Although the Kenya dairy sector has a significant contribution to the national economy, household incomes and food security, the industry faces a number of social and economic problems in milk production, processing and marketing. Milk production has not kept up with the demand due to poor adaptations and innovativeness among other challenges (Amwata & Mutavi 2018). These constraints affect the ability of the small-scale dairy farmers to maximise their production and to achieve sustainable incomes from the sector (Kanyinga, 2008). Inadequate nutrition is a major constraint that impact negatively on the growth and viability of dairy cattle farming in Kenya (Njarui et al., 2010).

2. Methodology

The study was carried out in Cheborge which is in Kericho County, 40 km. away from Kericho town and 15 km. away from Sotik town, Bomet County with the nearest town being Litein and 8 km away. Most households are small-scale farmers owning small pieces of land occasioned by continuous demarcations that can hardly sustain livelihoods. Farmers grow both cash and food crops with the leading cash crop being Tea. The food crops are mainly maize and vegetables. Most house- holds also practice small scale dairy farming, the focus of this study. Cheborge has a population of 2000 people and it overlooks a vast tea plantation called Sotik Tea. This study area was chosen purposively because of the possibility of answering the research questions and it is dominated by small-scale dairy farming.

This study utilised a mixed methods approach collecting both qualitative and quantitative data. It was predominantly a qualitative study particularly a descriptive survey research design which allowed an in-depth and exhaustive investigation. It was also exploratory in nature which allowed collection of data on less explored phenomena. Descriptive study was preferred as recommended by (Kothari, 2003) because it allows the researcher to describe, record, analyse and report conditions that exists or existed and, in this case, collecting data from the farmers. The target population was smallholder farmers selecting a sample of 109 who were selected by way of purposive sampling, bringing the total sample size to119, representing 20% of the population. According to Mugenda andMugenda (2003), a sample size of 10% of the population is adequate for generalization of findings to the whole population.

The research involved the collection of secondary data from books in libraries and internet sources for the purposes of thematic literature review. Primary data was obtained through collection of first-hand data by use of face to face administration of semi structured questionnaires. The researcher obtained official letters from the University and relevant authorities. A permit was also obtained from NACOSTI (National Council of Science and Technology) to carry out the research. Quantitative data was analysed through descriptive statistics while qualitative data was analysed through content analysis (Nachmias & Nachmias, 1997). Frequencies, percentages, and pie charts were used to report the findings.

3. Results and Discussion

A total of 119 questionnaires were administered during this study by the researcher and assistant researchers. 80 questionnaires were properly filled and returned, representing a 67 % response rate.According to Mugenda and Mugenda (2003) a response rate of 50% is adequate while 60% is a good representative and qualifies for analysis.Majority of the farmers, (87%) of the respondents were men while (13%) were women. The huge gap can be attributed to marginalization of women in asset ownership, a phenomenon that is common in African culture.

3.1. Farmers' Dairy Practices on Milk Production in Cheborge Location Farm Sizes

The respondents were sampled on the acreage of their land against milk production as per the chart below:

3.2. Farm Size and Milk Production per Cow

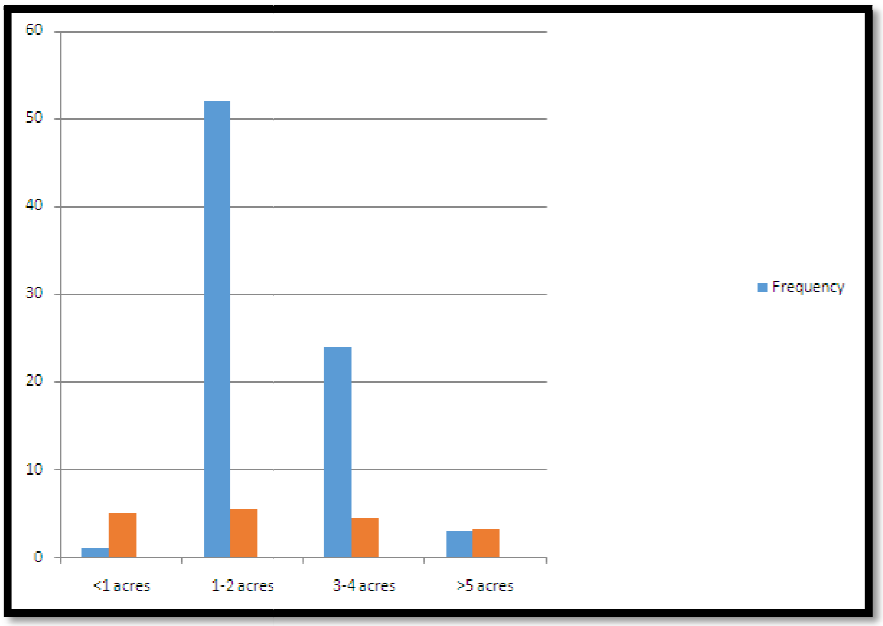

Figure 1: Farm Size and Milk Production per Cow
Source: Research Findings

Only (3.75%) of respondents had more than 5 acres of land against the daily average milk production of 3.1 litres per cow. The bulk (65%) own between 1-2 acres against milk production of 5.42 litres per cow per day, and 24(30%) own 3-4 acres against average milk production of 4.5 litres per cow per day. Only 1(1.25) owned less than one acre against milk production of 5 litres per day. The strength of the relationship between land size and milk production was examined by use of Spearman's moment correlation coefficient and it showed a negative correlation of r=-0.912. This is because of the intervening variables of different farming systems carried out by the respondents. The respondent with less than one acre for instance practices zero grazing and so produces more milk than the respondents with more than 5 acres but practising open grazing. 80% of the respondents practising zero grazing own between 1-2 acres, 18.75% own 3-4 and 1.25% representing only one respondent owns less than one acre. All the respondents carry out mixed farming of food and cash crops on their farms which leaves only a small portion for animals and a small space to grow fodder. Farmers with bigger parcels of land tend to give priority to cash crop of tea. This concurs with studies done by Tacken, (2009) who found out in his studies that production of food crops is more prioritized by farmers in ensuring food security. Further, cash crops like tea and coffee are believed to be income generating practices in the farms, and mostly preferred to milk production (Tacken, 2009).

3.3. Herd Size and Milk Production

The respondents were sampled on the number of dairy cows they reared, against milk production per cow as per the chart below:

No. of Dairy Cows	Frequency	Percentage	Avge. Milk Production per Cow/Day in Litres
1-2	33	41.25%	5.42
3-4	38	47.50%	4.5
5-6	8	10%	4
>7	1	1.25%	4.1

Table 1: Herd Size and Milk Production

As per the above table, 33(41.25%) of the respondents reared 1-2 dairy cows with average production of 5.42 litres per cow, 38(47.5%) reared 3-4, with average production of 4.5 litres of milk per cow and 8(10%) reared 5-6 cows with average production of 4 litres per cow. Only 1 respondent (1.25%) had more than 7 dairy cows with average production of 4.1 litres per cow. Pearson moment correlation co-efficient showed no relationship between the two variables, (size of the herd and milk production per cow) because of the intervening variable of farming system, (open and zero grazing). Of note however is the fact that 80% of the farmers who practice zero grazing rear the fewest cows (1-2) but with the highest milk production of 9 litres per day on average.

`The findings are in line with studies done in Denmark where the number of dairy cows has been slowly declining over the last decades mainly due to the overall quota regulation, where the maximum milk production has been reached

with improvement of the productivity of the single cow, and thereby reducing the overall number of cows needed (Hansen, 2015).

3.4. Farming System

The respondents were asked what farming system they practised with choices of zero crazing, semi-zero grazing, and open grazing. Their responses were analysed against milk production in each category and the findings are as per the chart below:

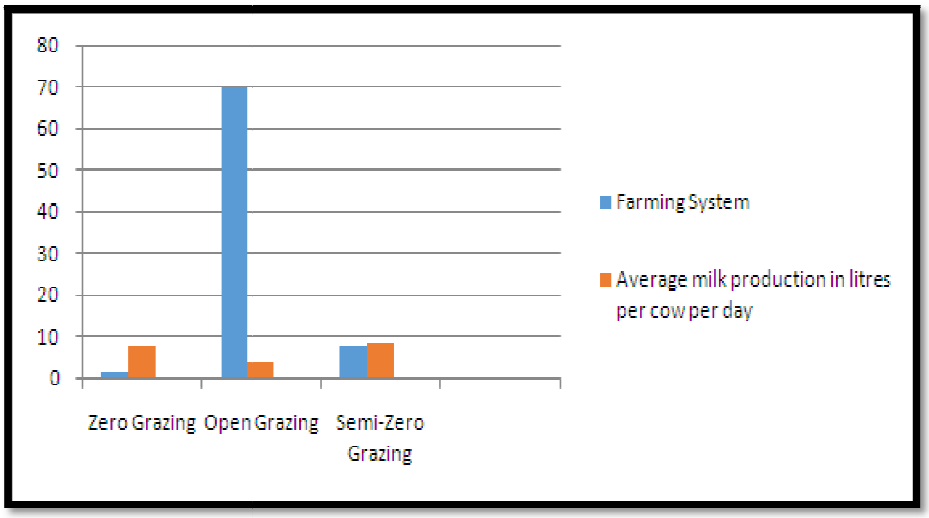

Figure 2: Farming System
Source: Research findings

Of the respondents sampled, 70 (87.5%) practice open grazing whereas 10 (12.5%) practice zero and semi-zero grazing. According to the findings, the category of farmers who practice zero and semi zero grazing produce more milk per cow, on average 9 litres per cow per day whereas the open grazers produce 3-4 litres per cow per day on average. This can be attributed to the land sizes which are too small for open grazing and which leaves no space to grow fodder. On the other hand, zero-grazed cows are fed better with concentrates and fodder which is grown on the land they would otherwise use for grazing.

3.5. Types of Cattle Breed

When respondents were asked what type of dairy breeds they reared, their responses were as follows:

Animal Breed	Frequency	Percentage
Friesians	40	50%
Jerseys	2	2.5%
Ayrshires	20	25%
Zebus	0	
Other (Combination of the crosses)	18	22.5%
Total	80	100%

Table 2: Types of Cattle Breed

All the above are crosses between indigenous and exotic cattle, and therefore, not purebreds. From the table above 50% of the respondents rare Friesians, 2.5% rare Jerseys, 20% Ayrshires, and a combination of both Friesians and Ayrshires are reared by 18% of the respondents. Only one respondent reared purebreds of Ayrshires and is the leading in milk production. No respondents reared Zebus because they have been crossed with the other breeds over the years. Whereas AI technology has helped in passing superior genes to dairy cows, farmers also borrow superior bulls from each other to serve their cows.

The above findings are in line with studies done in Magreb countries (Algeria, Morocco and Tunisia), where the official policies in the three countries encourage an improvement of the average milk yield per cow rather than the increase in the number of cattle (Sraïri, Benyoucef, & Kraiem, K. (2013). To achieve such, an increase of the milk output, one of the most prominent measures adopted was a program of crossbreeding of local strains with high genetic merit breeds like the Holstein and the Brown Swiss. Consequently, imports of cattle of such breeds were encouraged (Srairi & Farit, 2001).

3.6. Cattle Feeds

The respondents were asked what supplements they gave their dairy cows to enhance milk production with

3.7. Types of Cattle Feeds

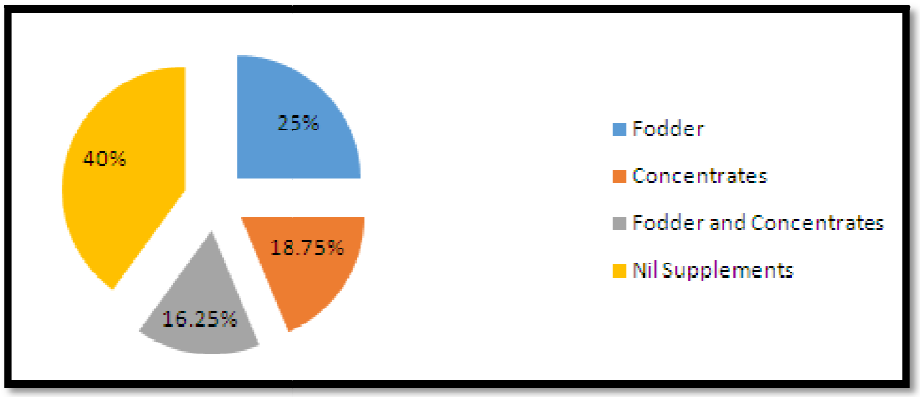

Figure 3: Types of Cattle Feeds

According to the above pie chart, 20 (25%) of the respondents use fodder which is mainly Napier grass, Boma Rhodes and to a small extent Lucerne to supplement cattle feeds. 15(18.75) use concentrates, specifically dairy meal while 13(16.25%) use both fodder and concentrates as supplements. All the respondents practising zero and semi zero grazing fall under this category and they are the highest in milk production. Results also showed that 32 respondents representing 40% however do not use any supplements. They just graze their animals citing the high cost of the manufactured concentrates as the reason they do not purchase it. They also use most of their land for food and cash crops, leaving no space to grow fodder for cattle.

The above findings are similar to studies done in Indonesia where poor milk production is experienced due to lack of essential knowledge of nutrition. Other constraints facing farmers are unavailability of forage grasses, lack of water, poor quality of concentrates etc which leads to poor milk quality and production (Nugroho, 2011*).*

The respondents were asked their level of agreement on the following statements and their responses recorded.

	Strongly Agree	**Agree**	**Neutral**	**Disagree**	**Strongly Disagree**	**Total**
Cows are provided with an adequate supply of fresh drinking water each day	10 (12.5%)	70 (87.5%)	0	0	0	100%
Feeds are stored in a clean place, free from contamination.	0	16 (20%)	64 (80%)	0	0	100%
Milk is harvested under hygienic conditions to prevent contamination	10 (12.5%)	50 (62.5%)	0	20 (25%)	0	100%

Table 3: Animal Husbandry

In regards to the adequacy of water supply, 70% drive their cows to the rivers which are just close by and hardly ever run dry. The area is also known for adequate rainfall throughout the year. Those who strongly agree (10%) have got wells and storage tanks in their homes and some have piped water from the river. About feeds being stored in a clean place free from contamination, 20% agreed while 80% were neutral. The neutrality can be attributed to fact that most of the respondents do not feed their cows on the manufactured concentrates which requires high hygiene. When asked whether milking was done under hygienic conditions, 12.5% strongly agreed, 62.5% agreed and 25% disagreed.

3.7.1. Cleaning of the Cowshed

When respondents were asked how often they cleaned their cowshed, only 10 (12.5%) said they did it 2 or 3 times a week while the majority 70 (87.5%) hardly cleaned their cowshed. Those who regularly clean, (12.5%) are those who practice zero and semi zero grazing methods. It should be noted that unhygienic cow shed is one of the leading causes of mastitis disease in cows which affects milk production negatively.

The findings confirm the studies done in Indonesia's small scale dairy farmers by Isyanto, & Dehen(2015)where poor yield was attributed to, among other factors, poor hygienic conditions in most dairy barns.

3.7.2. Breeding of Dairy Cows

The respondents were asked whether they bred their dairy herd by use of artificial insemination (AI) or by use of traditional local bull and their responses were as per the chart below:

3.7.3. Breeding of Dairy Cows

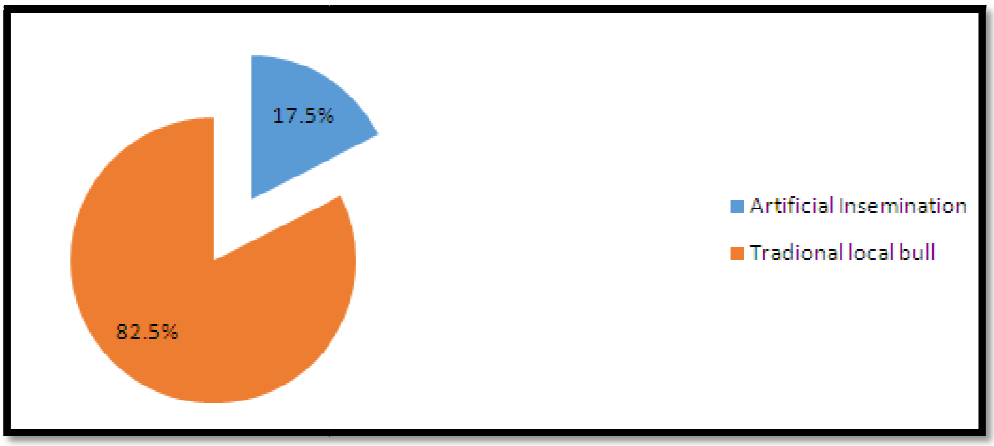

Figure 4: Breeding of Dairy Cows

As per the above chart, 14 (17.5%) use A.I to breed their herd whereas most of the respondents 66 (82.5%) use traditional local bull. This group cite the high cost of A.I. services and the inability to detect precisely when the cows need to be served leading to several failures before conception as the reasons for preferring to use a bull. It should be noted here however that A.I is a superior technology for disseminating superior genes to cows. It improves the quality of the herds and hence milk production. It also minimizes breeding diseases, shortens calving intervals and eliminates the cost of keeping a bull among other benefits. These findings are supported by studies done in Zimbabwe by (Land O'Lakes, 2013) where they found out that artificial insemination services, vaccines, veterinary drugs and antibiotics that are necessary to improve quality and quantity of milk are beyond the reach of small-scale dairy producers.

4. Conclusion

In regards to farmers' dairy practices on milk production, the study concludes that indeed, farming practices affect milk production to the extent that farmers who have embraced modern farming practices like zero and semi zero produce more milk compared to farmers who practise open grazing. The study also concluded that most of the farmers who practice open grazing do not give their dairy cows manufactured supplements which is one of the causes of low production. Those who practice zero and semi-zero grazing on the other hand feed their cattle with all the concentrates and lots of fodder besides availing water in the barn, a practice that boosts their milk production. The study also concluded that the zero and semi zero grazers are healthier because the cowsheds are cleaned regularly. Further studies need to be done however on the efficacy of AI technology as high failure rate was reported. On members' perception of cooperative societies, the study concludes that members find their membership in Cherobu co-operative society quite beneficial because of the services they receive. This is in spite of the low prices they get for their milk. Furthermore, their incomes have been boosted by the availability of chilling tanks which enables them sell their milk throughout the day unlike their counterparts who sell their milk to middle men perhaps just once a day. The study also concludes that access to manufactured feeds, veterinary and AI services on credit has a positive effect on milk production.

The study concludes that poor prices offered by cooperative societies and late payments are some of the main challenges facing farmers. Poor road network is another challenge as it causes delays in milk collection leading to spoilage and hence milk rejection. This happens particularly during rainy season. The study also concludes that access to loans was a challenge to most farmers due to various reasons, one being the fact that most of these farmers have no collateral. The fact that most financial institutions do not have branches in the rural areas is another draw-back. The study concludes that farmers lack sensitization on how the loans would assist them improve their dairy production. The study also concludes that most farmers are apprehensive of taking loans because of the risks associated with such loans.

5. Recommendation

Based on the findings of the study it is recommended that farmers need to embrace modern farming methods. Zero grazing has proved to be highly efficient and productive given the shrinking sizes of land which cannot sustain open grazing. It is also recommended that farmers maintain high hygienic conditions in the cow sheds by cleaning them regularly to keep their dairy animals healthy. Study findings further showed that most farmers do not feed their dairy cattle with manufactured concentrates and forage thus reducing their milk production. This is particularly true of open grazers. It is therefore recommended that they all embrace the practice of supplementing their cattle feeds with these concentrates to boost their milk production. It is further recommended that the Government offers extension services so that they can teach farmers best farming practices.

6. References

i. Aggarwal, A. K. (2018). "Rural Entrepreneurship Development"–an Emerging Paradigm for Rural Economic Development Through Entrepreneurship in India.
ii. Allison, E.H., and B. Horemans (2006) Putting the Principles of the Sustainable Livelihoods Approach into Fisheries Development Policy and Practice. Marine Policy 30(6), 757–766. doi:10.1016/j.marpol.2006.02.001
iii. Amwata, D. A., & Mutavi, S. K. (2018). Constraints and Opportunities Among Small Scale Peri-Urban Dairy Farmers in the South Eastern Kenya Rangelands.
iv. Atieno, R., & Kanyinga, K. (2008). The revitalisation of Kenya Cooperative Creameries: The politics of policy reforms in the dairy sector in Kenya. Future Agricultures Research Paper, 9.
v. Bai, Z., Lee, M. R., Ma, L., Ledgard, S., Oenema, O., Velthof, G. L., ... & Li, S. (2018). Global environmental costs of China's thirst for milk. Global change biology, 24(5), 2198-2211.Bebe, B. O. (2003). Herd dynamics of smallholder dairy in the Kenya highlands.
vi. Bebe, B. O., Udo, H. M. J., Rowlands, G. J., & Thorpe, W. (2003). Smallholder dairy systems in the Kenya highlands: cattle population dynamics under increasing intensification. Livestock production science, 82(2-3), 211-221.
vii. Behera, U. K., & France, J. (2016). Integrated farming systems and the livelihood security of small and marginal farmers in India and other developing countries. In Advances in Agronomy (Vol. 138, pp. 235-282). Academic Press.
viii. Brandt, P., Herold, M., & Rufino, M. C. (2018). The contribution of sectoral climate change mitigation options to national targets: a quantitative assessment of dairy production in Kenya. Environmental Research Letters, 13(3), 034016.
ix. De Haan, L. J. (2012). The livelihood approach: a critical exploration. Erdkunde, 345-357.
x. Farhat, M. (2016). The Effect of Relationship on Customer Loyalty (Case Study: Dairy Company Kale). International Business Management, 10(20), 4999-5005.
xi. Grace, D., & McDermott, J. J. (2011). Livestock epidemic. Routledge.
xii. Hansen, B. G., & Jervell, A. M. (2015). Change management in dairy farming.
xiii. Hemme, T., & Deeken, E. (2005). Selected Results of the IFCN Dairy Network Milk Prices and Costs of Milk Production in 2003. In 15th Congress, Campinas SP, Brazil, August 14-19, 2005 (No. 24274). International Farm Management Association.
xiv. Isyanto, A. Y., & Dehen, Y. A. (2015). Sustainability Analysis of Beef Cattle Fattening in Ciamis Regency, West Java Province, Indonesia. Journal of Economics and Sustainable Development, 148-154.
xv. Jones, P., Comfort, D., & Hillier, D. (2018). Common Ground: the sustainable development goals and the marketing and advertising industry. Journal of Public Affairs, 18(2), e1619.
xvi. Kassie, M., Stage, J., Diiro, G., Muriithi, B., Muricho, G., Ledermann, S. T., ... & Zeyaur, K. (2018). Push–pull farming system in Kenya: Implications for economic and social welfare. Land Use Policy, 77, 186-198.
xvii. Kumari, S., Sethi, N., & Malik, J. S. (2018). Impact of Training on Dairy Farm Women. Journal of Community Mobilization and Sustainable Development, 13(2), 267-270.
xviii. Land O' Lakes (2013), Rebuilding Livelihoods and Resiliency in Zimbabwe Project, Quarterly Report January-March 2013. Submitted to the United States Agency for International Development/Zimbabwe.
xix. McCarthy, U., Uysal, I., Melis, R. B., Mercier, S., Donnell, C. O., & Ktenioudaki, A. (2018). Global food security–Issues, challenges and technological solutions. Trends in Food Science & Technology.
xx. Migose, S. A., Bebe, B. O., de Boer, I. J. M., & Oosting, S. J. (2018). Influence of distance to urban markets on smallholder dairy farming systems in Kenya. Tropical animal health and production, 1-10.
xxi. Milne, G. (2018). Animal Diseases and their Threat to Food and Food Security. The CIP Report.
xxii. Morse, S., & McNamara, N. (2013). The theory behind the sustainable livelihood approach. In Sustainable Livelihood Approach (pp. 15-60). Springer, Dordrecht.
xxiii. Mugenda, O. M., & Mugenda, A. G. (2003). Research methods. Quantitative and qualitative approaches.
xxiv. Mutua, F., Onono, J., Bruck, A., & Makau, L. (2018). An overview of animal health and communication constraints in smallholder farming systems of Machakos County, Kenya. Tropical Animal Health and Production, 1-
xxv. Muriuki, H., Omore, A., Hooton, N., Waithaka, M., Ouma, R., Staal, S. J., & Odhiambo, P. (2003). The policy environment in the Kenya dairy sub-sector: A review. Smallholder Dairy (Research and Development) Project, Nairobi, Kenya.Mwacharo, J. M., Ojango, J. M., Baltenweck, I., Wright, I. A., Staal, S. J., Rege, J. E. O., & Okeyo Mwai, A. (2008). Livestock productivity constraints and opportunities for investment in science and technology.
xxvi. Mwendia, S. W., Mwungu, C. M., Karanja Ng'ang'a, S., Njenga, D., & Notenbaert, A. (2018). Effect of feeding oat and vetch forages on milk production and quality in smallholder dairy farms in Central Kenya. Tropical animal health and production, 50(5), 1051-1057.
xxvii. Nachmias, D. & Nachmias, C. (1976). Content analysis. In Research methods in thesocial sciences (pp.132-139), UK: Edward Arnold.
xxviii. Njarui, D. M. G., Gatheru, M., Wambua, J. M., Nguluu, S. N., Mwangi, D. M., & Keya, G. A. (2010). Challenges in milk processing and marketing among dairies in the semi-arid tropical Kenya. Livestock Research for Rural Development, 22(2), 35-36.
xxix. Nugroho, B. A. (2011). The Relevance Of A Rules-Based Freshmilk Price Structure Policy In East Java: An Evidence Based Assesment. Asian Journal of Agriculture and Rural Development, 1(2), 50.

xxx. Omore, A. O., Muriuki, H., Kenyanjui, M., Owango, M., & Staal, S. J. (1999). The Kenya dairy sub-sector: a rapid appraisal.
xxxi. Owango, M., Staal, S. J., Kenyanjui, M., Lukuyu, B., Njubi, D., & Thorpe, W. (1998). Dairy co-operatives and policy reform in Kenya: effects of livestock service and milk market liberalisation. Food policy, 23(2), 173-185.
xxxii. Phillips, C. J. (2018). Principles of cattle production. CABI.
xxxiii. Pica-Ciamarra U., Baker D., Morgan N., Zezza A., Azzarri C., Ly C., Nssima L., Nouala S., Okello P., and Sserugga J., 2014. Investing in the livestock sector: why good numbers matters. A sourcebook for decision makers on how to improve livestock data. World Bank report Number 8572-GLB, Washington DC.
xxxiv. Prajapat, R. (2014). An Economic Analysis of Production and Marketing of Milk in Jaipur District of Rajasthan (SKNAU) (Doctoral dissertation, SKNAU).
xxxv. Rademaker, C. J., Oosting, S. J., & Jochemsen, H. (2018). Modernising the Kenyan dairy sector?. In Professionals in food chains (pp. 97-104). Wageningen Academic Publishers.
xxxvi. Rufino, M. C., Herrero, M., Van Wijk, M. T., Hemerik, L., De Ridder, N., & Giller, K. E. (2009). Lifetime productivity of dairy cows in smallholder farming systems of the Central highlands of Kenya. Animal, 3(7), 1044-1056.
xxxvii. Small, L. A. (2007). The sustainable rural livelihoods approach: a critical review. Canadian Journal of Development Studies/Revue canadienne d'études du développement, 28(1), 27-38.
xxxviii. Sraïri, M. T., Benyoucef, M. T., & Kraiem, K. (2013). The dairy chains in North Africa (Algeria, Morocco and Tunisia): from self sufficiency options to food dependency?. SpringerPlus, 2(1), 162.
xxxix. Staal, S. J., Baltenweck, I., Waithaka, M. M., DeWolff, T., & Njoroge, L. (2002). Location and uptake: integrated household and GIS analysis of technology adoption and land use, with application to smallholder dairy farms in Kenya. Agricultural Economics, 27(3), 295-315.
xl. Tacken, K. J., Vogelsang, A., van Lingen, R. A., Slootstra, J., Dikkeschei, B. D., & van Zoeren-Grobben, D. (2009). Loss of triglycerides and carotenoids in human milk after processing. Archives of Disease in Childhood-Fetal and Neonatal Edition.
xli. Tangka, F., Ouma, E. A., & Staal, S. J. (1999). Women and the sustainable development of market-oriented dairying: evidence from the highlands of East Africa.
xlii. Thorpe, W., Muriuki, H. G., Omore, A. O., Owango, M. O., & Staal, S. J. (2000). Dairy development in Kenya: the past, the present and the future.
xliii. Udo, H. M. J., Aklilu, H. A., Phong, L. T., Bosma, R. H., Budisatria, I. G. S., Patil, B. R., ... & Bebe, B. O. (2011). Impact of intensification of different types of livestock production in smallholder crop-livestock systems. Livestock science, 139(1-2), 22-29.
xliv. Urassa, J. K., & Raphael, E. (2017). The contribution of small scale dairy farming to community welfare: a case study of Morogoro Municipality.
xlv. Wambugu, S., Kirimi, L., & Opiyo, J. (2011). Productivity trends and performance of dairy farming in Kenya. Tegemeo Institute of Agricultural Policy and Development.