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Forage Management by Small Scale Dairy Farmers as an Economic Activity in Bungoma County-Kenya

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Abstract: **Forage management is a very important aspect in livestock management in Kenya. Animals' feeds are too expensive and this affects milk yield among majority of low resources farmers. Inadequate feeds and low nutritional level of the available feeds limits milks production while the animal's commercial feeds are too expensive to buy by majority of low income farmers. Despite the importance of forage to human welfare, farmers are reluctant to invest in their production using new technologies like cultivation, fertilizations, growing of new varieties and conservation as they do to other food and cash crops. The study was to evaluate forage management by small scale dairy farmers in Bungoma County. The objectives of the study were to establish relationship between forage management on milk production, and to analyze the effect of new technologies on fodder production on milk production in Bungoma County Kenya. Cost benefit Analysis model was employed and established that there w economics of agricultural technologies as a significant relationship between the variables. The study revealed that good forage management, were predictors of high milk yield, and variables such as new technologies like cultivation, fertilization, growing of new varieties and conservation were equally significant in high milk yield. Policy makers, to disseminate to farmers improved forage technologies frequently.**

Keywords: **Forage management, Yields, Cost Benefit Analysis, Small holder farmers, Production.**

1. INTRODUCTION

Roughages are feeds with high fiber content (non-digestible materials) and can be defined as food for farm animals. According to stotz (1983) forage production systems can be distinguished on the basis of sources and feeding methods. Therefore these are different types of livestock feed on the farm. They include pastures, arable fodder crops and food residues. The primary purpose of forage production is feed to livestock which can be converted into protein rich products for man.

Forage can be dived into four main groups. These include crops like fodder maize (zeamays) oats (Arena sahia) , sorghum, (sorghum vulgoris), cowpeas (vigena susensis) and soya bean (glycene soya). The second types include commonly grown forages which are specifically for livestock such as giant tropical grasses which include, Napier grass pennisetum, purpereum, guatemala grass (tropicum laxum)3rd Lucerne or alfalfa (medicago, lupulina, clovers (Trifolicenisp); disodiuma and leucaena. Others include fodder trees and shrubs. Farmers can grow a variety of forage chosen to suit a specific environment both legume and non-legumes on their farms. This will ensure a balanced diet to the animals for increased productivity and lessen the purchase of external animal feed which are costly to farmers (ILR, 1997).

Due to the importance of dairy sub- sectors in Kenya strategies have been mounted to improve its productivity. One strategy is to reduce the gap between the potential milk yield and the current milk yields; and to focus research on small

holder dairy farming intensification. The other strategy is by planting a number of forage as pure stand, mixed stand, application of fertilizers and farm yard manure. The forages should also be utilized efficiently by feedings to the livestock at the right stage of growth period and without wastage (Ibrahim 1985).

Increasing forage production will increase the carrying capacity of dairy animals and therefore, contribute towards self-sufficiency in food production and cash generation.

1.1 Background:

Livestock farming is an important economic activity in Bungoma County, a Kenyan popular county. At small holder levels where mixed farming is practiced, forage crops forms a major source of animals feeds. Therefore as farming land becomes scarce, more attention must be given to their proper harvest, storage and use. Livestock plays an important economic role as they provide milk, eggs, meet, skin/hides, drafts power, and manure for improving soil fertility etc. Socially it is a major source of wealth, pride and a status symbol for settling dowry payments.

At household levels, it is termed as the living bank for farmers as it provides flexible financial resources to the household (ILCA, 1993). Thus livestock and livestock products are sold, and can be used to purchase farm inputs and foodstuffs.

Despite its importance, livestock and livestock products are low in production, therefore to attain the objective of high productivity and have profits, there should be more emphasis given to dairy research and extension to key limiting areas such as dairy feeds and feeding systems, breeding systems and animal husbandry. Thus demand for research to evaluate forages and fodders trees which are the basic feeds for livestock.

The options to increasing milk production includes; improved nutrition through supply of adequate quality feeds, better dairy breeds and proper disease control. However, at householder level, feed quality and quantity is the most limiting or constraining factor to increase dairy productivity (ILR, 1997). Commercial concentrate feeding as a solution for increased dairy livestock production is limiting because of their ever escalating costs and remains a supplement to few resource endowed farmers. However, due to limited land resource, intensification and efficient use of on-farm resources seems viable option. Intensification through growing a variety of forages and use of fertilizers to increase the yields and nutritional qualities of these forages (fodders) cannot only significantly alleviate the problem of poor nutrition but will also increase the supply of locally available feeds.

Increase in the carrying capacity of land can be achieved through improving fodder yields per unit area so that more livestock can be sustained per unit area of land. This will ultimately avail more feed required to cater for dairy cattle for increased milk production of between five and twelve liters per day per cow, (UNDP/FAO, 1984). Therefore by increasing Napier grass yield and that of other forages, milk production will increase too.

1.2 Statement of the problem:

Inadequate feeds and low nutritional level of the available feeds limits milks production while the animal commercial feeds are too expensive to buy by majority of low income farmers.

Despite the importance of forage to human welfare, farmers are reluctant to invest in their production using new technologies like cultivation, fertilizations, growing of new varieties and conservation as they do to other food and cash crops.

1.3 Objectives:

The general objective is to assess the importance of forage management to increased yield.

1.3.1Specific objectives were to;

1. Analyze the effect of new technologies such as land cultivation method, fertilizer application, growing of new varieties and use of conservation methods when developing forage, on wealth creation.

2. LITERATURE REVIEW

This section gives a review of the empirical work done on production, social and economic aspects of fodder production. This is intended to give a detailed understanding of studies done on fodder production systems at smallholder level.

2.1 Forage Production and utilization:

Evaluation on forage production can be done in items of economic, agronomic and nutritional aspects. All these analyses are important to the farmer decision making relating to the type of feed to grow as feed for livestock (Adesima 1993) has shown that economic constraint is a key determinant of technology adoption process of agricultural technology among farmers. Kariuki (1998), also evaluated Napier grass in terms of digestibility against other potential substitutes and suggested the supplementation with other feeds due to its low crude protein content. Alternatively, nutritional level of fodders can be increased through fertilization using inorganic and organic fertilizers. Snyders et al. (1992), showed that application of inorganic fertilizers and organic manures enhances nutritional quality of Napier grass. He went further to observe that quality and quantity of Napier grass is a function of climatic factors (rainfall, temperature), soil fertility status (fertilization) and other agro-ecological conditions of the location under consideration.

From an economic point of view forage production is a derived demand because it depends on livestock productivity. Thus, when fodders are efficiently produced and effectively fed to dairy cattle it is more profitable on the farm (Stotz, 1996). Studies by Ibrahim et al(2006), indicated that when improved fodder under good management are used, the net profit from the grade cows under zero grazing systems was higher than from crossbreed and zebu cows under similar system. The profit was also higher compared to Zebu cows grazing pastures (Ibrahim et al, 2006). It has also been shown that profitability increases if the farmers sells some of the calves, uses slurry to produce cow-dung and use slurry to fertilize fodders (NARC, 1984, Mogaka, 1993). MAULDM (992), also indicated that Napier grass is the main high yielding fodder used by dairy farmers in Kenya particularly those with intensive production system of zero and semi-zero grazing systems (KARI, 1997)

Work done in western Kenya by United Nation development Programme(UNDP)/Food Agricultural Organization (FAO,2008), showed that returns from smallholder dairy based on intensive forage cropping was economically attracted compared to other livestock and crop activities. Return to labour was shown to be relatively high, giving Kshs. 7.10 per hour invested in the intensive livestock activity.

Orodho, (1992), found out that the coast of production of Napier grass and price of milk affects the adaption of the forage technologies. Thus, if price of milk is attractive then, the adaption of forage will increase because of the benefits derived from adequate milk as food and cash generation. Undo (1997), concluded from his study that for diary development to take place, not only are technical innovations are the key issues for higher livestock productivity but also the avaibility of good producer policies. These profit oriented incentive policies such as good prices, efficient marketing system for livestock and their by-products, and investment support like credit facilities, some of the technical innovation including fertilizer application and planting of forage variety in an economically efficient way. Poor quality feeds cannot contribute to higher milk and meat production.

MALDM (1992) analyzed profitability of natural pasture and Nandi setera grass fertilized at two application rates of 46 kg N and 76 kg N. Based on variable costs, it was found that fertilizer application on grasses gave better economic returns than the control (unfertilized). This type of information is very necessary for farm decision making relating to investments in forages on the farm. This is because at smallholder level, the most limiting resources are land and capital. Consequently, investment in forage feeds has to be based on which ones give the highest return per nutrient drawn from fodder grown on farm land.

Munguieri (1997) carried out a regression analysis of fertilizer application on maize (Zea mays) which is also a source of livestock feed as silage or farm by-products on Kisii and Busia site using experimental data. He found that farmers tend apply fertilizer below the optimal rates. Since it is assumed that farmers are rational people they could be having genuine socio-economic reasons for using such low rates. Nabwile (2013), did a similar work but on irish potatoes (ipomea tubarosum) and came up with similar conclusion that farmer fertilizer rates are below optimal rates.

Colwell (2005), observed that blanket recommendation can result in a very considerable general benefit to a region, but the benefits can be greater from site specific sites with respect to agro-ecological zonation, soil type and rainfall regimes. More so a site specific recommendation contributes to efficient use of fertilizers without under-dose or overdose. The later can even lead to environmental pollution and thus, degradation land resource. For an overdose of nitrogenous fertilizers can lead to water pollution.

2.2 Factors influencing forage production and utilization:

Factors that influence forage production and utilization are technical, social and economic in nature. For example studies undertaken in Kenya and elsewhere indicate that quality and quantity of Napier grass is a function of soil fertility. This includes climate, cultural practices, the stage of growth, height at cutting, milk availability and price of inputs like concentrates and fertilizers (Orodho, 1992). These differences in respect of the above factors call for specific guidelines in the process of technology development and transfer in order to meet the demands in terms of food and cash of farmers and optimize economic returns.

High productivity of fodder in Kenya and the subsequent milk productivity at smallholder level has not been achieved by majority of small-scale farmers because of diverse problems. The non-adoption has been attributed to inappropriateness of technologies extended to these farmers. The relatively high input cost of production, poor technology dissemination and poor marketing system and poor milk pricing have contributed to low economic profits of dairy production.

Abate (1990) indicate that all feeding systems of dairy cattle in Kenya are deficient in at least one nutrient because of poor feeding. Therefore, growing and feeding a number of forage types to dairy animals is superior to feeding only one type. This calls for technology developers, disseminators, farmers and other stakeholders affected to examine both agronomic and economic performance of other alternative fodder with good attributes

It has been indicated that 7.6 liters of milk per day can be achieved from feeding roughage only (Mogaka, 1993). This implies that at current (2015) milk price of Ksh. 50,000 per litre will get gross income from feeding roughage would be about Kshs. 380.00 per day. This is relatively beneficial and justifies the need for increasing fodder productivity. Among the most important fodders that can be grown are: Napier grass, giant setaria, Rhodes grass, giant panican, Guatemala and the local indigenous grasses.

(Congo Signal, Kikuyu grass, star grass, coloured guinea, Rhodes grass, guatemalla).

Most of the forage technologies were developed through On-Station experiments and less consideration on the farmer environment circumstances. Socioeconomic analyses of the technologies were not considered. Thus, culminating in most of the technologies being rejected by the farmer. In some cases adjust technologies have been forced to suit their conditions like the Tumbukiza method of napier grass production is one such adjustment designed by farmers. In this method several sticks of Napier grass are planted in relatively deep hole. Moisture and fertilizer are higher in the pit and in a dry spell the grass does not suffer from water stress as much as in the conventional methods.

3. COST BENEFIT- ANALYSES (CBA)

Forage production of perennial fodders is a capital investment as costs and benefits accrue over a period of time. They require initial high investment with no or fewer benefits in the initial periods unlike the subsequent years. Therefore, economic analyses of the viability of pasture forage technologies was based on the discounted values of future annual income streams for a definite number of years in this case economic life cycle of the perennial fodders. For ease of analysis the trials were grouped into Tree/shrub legume, herb forage legumes, ley pastures and soil amendments on napier grass. Investment appraisal methods used were; Net worth techniques which included Net Present Value (NPV), the NPV gave a positive figure meaning the project of forege management as an economic activity is viable.

3.1 Results and Discussion:

Farm size:

Land resource is an important item in the African social setup and also an indicator of social and wealth status in most communities in Kenya. It is worth noting that all farm enterprises compete for this limited resource and eventually affects the adoption of a technology and farm management practices. Based on household goals and preferences, land allocation to different enterprises may be an indicator of priority decisions by farmers.

The mean farm size in highly populated district of Bungoma is highest in rural areas. Thus, because of high farm sizes, emphasis on forage production should be geared towards high yielding forages including intercropping systems in the densely populated districts. Small farm size demands intensive technologies like inter-cropping and fertilizing in order to meet livestock feed requirements annually.

3.2 Milk production at farm level:

Amount of milk produced at farm level can and is an indicator of how well the animals are nourished. Poorly fed animals are vulnerable to diseases with even low calving intervals. The milk price can be an incentive or disincentive to good animal feeding. The farmers have few forage types planted. Thus the diversity of forages as primary sources of nutrients and dry matter is limited. This decreases nutrient sources from forages at farm level. Also from the survey, level of fertilizer application is generally low. However, there is great potential for increased fertilization on fodder because of increasing prices from milk and meat. The diminishing farm sizes calls for intensification of forage production by increased use of locally available inputs like organic manures and inter-cropping innovations particularly with other forages, food and cash crops.

3.3 Yield levels of forages:

The yield levels of forages were presented and the mean yields from replications (farmers) were given. The Standard deviation of cuts/harvests made annually are given for each year, and ranged between 0.19 and 2.43 while the Coefficient of Variation (CV) varied between 25% to 64%.The annual yields for the last 2-3 cuts were generally low due to poor rainfall distribution. This was during the short rains or/and dry spells. This periods apparently coincides with feed inadequacy in these region and also low milk production (Rees et al, 1996). Therefore this calls for strategic management of feeds and feeding system during this period.

3.4 Cost Benefit Analysis:

This section shows the results of Cost Benefit Analysis using discounted cash flow approach for the forage technologies identified by National Agricultural Research System (NARS). The methods used to evaluate the efficiency and economic attractiveness of the technologies in resource use were NPV, IRR, BCR and returns to labour. It should be noted that BCR can be used directly in sensitivity analysis. These techniques take care of time and magnitude of cash flows in the course of forage economic life cycles. Sensitivity analysis to deal with risks and uncertainties is also shown. Profitability indicators provide criteria for decision making on technology which was a net cash flow of Ksh. 10, 000.00 annually for three to five years from maize enterprise. This gives NPV of KSh. 22,837.00 for three years and Ksh. 33,528.00 for five years from maize. However, profits of maize can double in some periods which makes NPV rise to Ksh. 113,142.00 for five years. These benefits from maize are compared to forage benefit during their life cycle. The difference in value makes the small holder farmers therefore not motivated to invest in forage

4. SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

Livestock is an important component of any given farming system and country at large because it is a source of food and cash a part from balancing the ecosystem. Forage feed is a key input in livestock production system. The broad objective of the study was to contribute towards developing cost-effective forage technologies for enhanced adoption and therefore increase the livestock productivity in the country for food and cash generation. This was achieved through an economic analysis of forage technologies identified by NARS specifically for western Kenya. The technologies can be applied elsewhere with similar biophysical and socioeconomic circumstances in the country. Two approaches used in the study; Cost Benefit analysis using discounted method was done on a variety of forages and forage production techniques. The Regression analysis was done on fertilizer application on napier grass which is a predominant forage among the smallholder farmers in medium and high potential areas of Kenya. It was also noted that fertilizer application increases nutrition of forages as indicated by Snydgers (1992).

NPV, BCR and return on inputs for example labour were the techniques used in the economic analyses. Profit maximization motive was assumed to be one of the objectives in decision making among majority of farmers and thus, they think in terms of costs and benefits. The profitability indicators showed that most forages were economically viable investments showing efficient use of resources while few were not. Thus, other than napier grass, there are other fodders that include; leucaena, calliandra, desmodiums, lucerne, rhodes grass, and coloured guinea. In spite of this the decision to recommend and to take up the technology depends on the adjustment of the technology as shown by sensitivity analysis to take care of uncertainty and improve the efficiency of resource use. Thus, farmers can grow a variety of forages both legumes and non-legumes on their farms. This will go to balance the diet of the animals for increased productivity and

lessen the purchase of external feedstuffs which are costly to farmers. Technologies with relatively low economic indicators can be economically attractive if the cost structure can be adjusted without significantly affecting the yields. The profitability of forages is comparable to maize enterprise.

The regression analysis showed that there was higher response of fertilizer application in the wet than dry seasons. And also the economic optima varies greatly between sites and seasons. This means recommendations should be based on seasonal variations and local conditions, therefore moving away from general fertilizer recommendations. The optimal fertilizer applications were generally higher than farmer's levels of application as shown by the deviations between optimal and farmer practice rates. This shows the ability of farmers to adjust the technology to save on external input purchase like low or no fertilizer applications. However, in quickly soil fertility degenerating soils leads to low yields which eventually give low profits and subsequent soil degradation. As indicated by Feder and Slade (2004), there is need to advise farmers on the profitability of technologies that have been recommended by farmers and research-extension team to other farmers. This is because it has been shown by Adesima, (1995) that accumulation of the information on the economic returns will induce farmers to gather more of this information on the innovations to try and eventually adopt. The information package of the technologies can be communicated to the end-users through on-farm experimentation, farmer evaluation forums, pamphlets, seminars and workshops. Thus there is need for an integrated approach to disseminating agricultural information to farmers.

Recommendations:

In order to develop and disseminate improved forage technologies that are technically, economically and socially acceptable frequent analysis of cost and benefit implications is necessary. This will keep pace with changing socio-economic environment and ensure sustainable production as farmers will continue using technologies available to them. From the study which was based on economic and social evaluation, most of forages as intermediate products in livestock production process were promising investments by farmers. The only ingredient for enhanced adoption is packaging and dissemination through adaptation trials and demonstrations. All stakeholders in agricultural technology development and transfer should be active participants. However, technology diffusion and adoption rates assessment be done to ascertain the impact to of the interventions to the farming community.

Emphasis on forage technology development and transfer should be tailored on growing a variety of forages both legumes and non-legumes in pure and/or mixed stands in order to boost animal productivity. It should be noted that perennial forages also contribute to food and soil conservation.

It was also noted that fertilization by farmers was generally low due to high cost of inputs. Use of optimum fertilizer programs to improve production and quality. Fertilization should be based on utilizing organic fertilizer more so, in combinations as they were economically attractive options. The organic fertilizers should not be seen as replacement to inorganic fertilizers but supplements. Forage conservation and utilization can be emphasized to be undertaken by farmers. The conserved forage can be sold to earn cash to meet household requirements that require cash. Options to combine direct grazing and hay making for ley pastures were viable investments. Fodder shrubs can be grown as hedge rows, boundary fences or soil conservation embankment where opportunity cost of land is low. It should be appreciated that inter-crops of legumes and ensure sustainable production as farmers will continue using technologies available to them. From the study which was based on economic and social evaluation, most of forages as intermediate products in livestock production process were promising investments by farmers. The only ingredient for enhanced adoption is packaging and dissemination through adaptation trials and demonstrations. All stakeholders in agricultural technology development and transfer should be active participants. However, technology diffusion and adoption rates be done to ascertain the impact of the interventions to the farming community.

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Primary objective to any livestock farmer, whether one produces for meat or milk is to return a satisfactory profit from the forage operations. This will require higher returns in the future because of increasing cost of production. Choice of type forage feed and method of utilization will be an important consideration, since forages represent a substantial percentage of input. This is because one of the deterrent factors to reaping maximum economic returns from forage could be inadequate utilization of forage produce. More important is that forage will continue a valuable source of feed in the future livestock operations. This will call for higher amounts of forages that of good quality. This will be achieved through fertilization plus other efficient management operations including the utilization.

Grazing system is still economically viable option for those farmers that have enough land to accommodate the practice. Therefore, future development of good management of grazing systems including the natural grasses will increase their productivity and profitability.

Guidelines for future direction:

Forages as intermediate products in dairy production were viable options in agricultural practices. This also calls for optimal input use like fertilizers which not only increases yields but also quality enhancement. However, reason that could dictate the uptake should be analysed further. They include the policy environment of input and output market of the livestock industry. Economics of seed production of forages and other by¬products need more research. Some of forage seeds are scarce and opportunities for farmers to make own seed for use and sell needs further study. The community based seed multiplication and availability should be an issue to look into.

Future forage production practices should be geared towards maximizing economic returns per unit of land. Efficient forage production operations will be demanded and due to competition in the current market. It should be targeted that the production practices being used by regressive farmers to be a common practice in the first half of this century.

Another aspect of research is to look more into the economics of organic and inorganic fertilization of forages. This includes fertilizer programming combined with good agronomic management, thus levels and frequency of fertilizer applications. The seasonal or annual application rates like the case of organic fertilizers should be properly documented. For example since organic manures are not available in sufficient quantities, rotational application may be an issue to look into.

Economics of nutrient levels of nutrients applied in the soil and the amount taken by the plants can lead to a more efficient way of utilizing the fertilizers. This study looked at the supply side of the nutrients, however, there is need to look at the demand side of the nutrients. What is the optimal level of nutrients in the plants? As the plant grows to determine the economical optimal cutting stage as a challenging area.

Recycling of waste products from forage consumption has a future challenge. The development of strategies for efficient utilization of manures could be economically efficient. The labour aspect in utilizing slurry or preparation and application of Farm Yard Manure in napier grass and general forage is an option for study. This is because manure utilization and pricing for this system has not been documented. More so the factors that limit the uptake of the forage technologies should be closed reviewed linking up the production and marketing of livestock and livestock products.

The study considered forage herbage as an output, however there is need to to evaluation forages after feeding to the animals. The benefits accruing as a result of the feeding in terms weight gain and milk yield will then be analysed.

The results found in this study is not static but dynamic therefore, the need to review them in appropriate periods due fast changing a socioeconomic situation which includes; price changes, input adjustments and biophysical changes like soil Ph.

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