LIVESTOCK FARMING AND POVERTY REDUCTION IN SMALL HOLDER FARMS IN KENYA

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Abstract

Smallholder livestock farmers are vulnerable to market conditions because their products are perishable and price elastic. The farmers earn low and fluctuating incomes that trap them in cycles of poverty. This paper looks at how poverty in the livestock subsector in the high agricultural potential areas of Kenya could be reduced through adoption of innovative farm practices. In the empirical analysis, primary data from Nyeri are used to estimate effect of increasing usage of animal feeds on farm incomes and poverty. The regression results show that the production effect of animal feeds is strongly positive despite the small quantities of feeds applied. The simulation results confirm that increasing the application of animal feeds in the livestock sector increases the output of livestock products and substantially contributes to poverty reduction in the study area.

Keywords: Smallholder livestock farmers, poverty reduction, animal feeds, farm income

1.0. Introduction[1]

Smallholder farms occupy a central place in Kenya's agriculture (Heyer, 1976; Republic of Kenya, 2006). In addition to meeting subsistence needs, they are expected to produce food and raw materials for local and overseas markets, create jobs and contribute towards poverty reduction (Republic of Kenya, 2004). In Nyeri County, small farms are said to have great potential to deliver residents out of poverty (Republic of Kenya, 2002), an issue that we explore further in this paper paying more attention to livestock farming.

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A majority of the smallholder farmers grow crops and rear livestock (Heyer, 1976; Republic of Kenya, 2006). The most common types of livestock reared include chicken, goats, sheep, pigs and cattle. The animals produce milk, eggs and meat that serve household consumption needs with surpluses being sold off in the local markets. Some of the produce is also sold to cooperative societies or exported to foreign markets. The main by-product of livestock farming is manure which is used as fertilizer in the farms.

Dairy farming in zero-grazing sheds is widespread in zones of high to medium agricultural potential where average household land holding is smaller than 5 acres (Republic of Kenya, 2006). Indigenous Zebu cows and their crosses are the main breeds. Average milk yield per cow often falls below 10 liters per day. There are, however, a few farmers that stock exotic high-yielding varieties such as Fresian and Ayshire in zero-grazing sheds and whose milk production is way above 10 liters per day (Senga, 1976). Farmers with higher milk production practice modern animal husbandry that includes use of appropriate inputs (Republic of Kenya, 2006).

Zero-grazing is quite demanding in especially labor. Some of the farmers that face labor constraints combine zero- and open-grazing. Livestock farmers neighboring forests take advantage of pastures in the forests to graze their animals at a small fee to Kenya Forest Service, but these pastures are often infested with diseases from wild animals. Livestock loses from diseases related to wild animals are common among farmers that graze animals in forests. The same applies to farmers that graze their animals along the roadsides. Roadside pastures are often infested by ticks and diseases.

In zones of low agricultural potential where land holding is comparatively higher averaging around 50 acres, open-grazing of especially beef cattle is common (Senga, 1976). Beef cattle are often reared alongside goats and sheep. Low agricultural potential areas receive low rainfall and they are prone to prolonged droughts that often claim thousands of animals with huge losses to the farmers. The pastures in the expansive grazing zones are frequently visited by wild animals that sometimes contaminate them with diseases and ticks posing great risk to domestic animals. The potential of beef farming in poverty reduction in arid and semi-arid areas is an important area for study, but the focus of this paper is on livestock farming in medium and high potential agricultural zones.

Dairy goats are progressively entering into the livestock matrix of smallholder farmers in view of rising demand for milk in a situation of declining land holding. However, goat milk is yet to penetrate local markets which are dominated by cow milk whether in pure form or in products such as yoghurt.

The market for livestock and livestock products in Kenya is volatile (Senga, 1976; Republic of Kenya, 2009, 2010). During dry seasons, supply of livestock for slaughter increases depressing prices for live animals. On the other hand, supply of milk declines and milk prices increase, albeit by small margins. During wet seasons, supply of livestock for slaughter drops as herders rebuild stocks and prices of live animals improve marginally. The supply of milk increases tremendously during wet seasons due to abundant pastures and fodder, and this drives down the price of milk by a big margin.

The market for eggs is also volatile. Gluts and shortages characterize this market and prices move in reverse to the swings in supply.

Other than for chicken, animals are sold on a per unit basis (Republic of Kenya, 2006). Prices are arrived at through haggling. The buyers often exploit the farmers since the latter have neither the haggling experience nor the knowledge about market prices. In the case of broiler chicken, the birds are slaughtered and sold on weight basis. Slaughtering is a form of value addition and it provides the farmer with a credible means of determining a better value for product. However, broiler prices vary widely with supply and tourism season. During peak seasons in the tourism sector chicken broiler prices are highest, and conversely.

Livestock output serves subsistence as well as cash needs of households (Heyer *et al*., 1976; Republic of Kenya, 1997, 2010). In producing for the market, the farmers have a price at which they expect to sell their produce. From the expected price and the output they produce, they further form expectations of the amount of revenue to be earned. By comparing the expected revenue to the costs of inputs, farmers decide whether to produce more livestock products. However, increased livestock output benefit a farmer only when it translates to higher income. Income is the product of quantity of output sold and the price (demand) at which the output is sold.

The revenue received by farmers is determined by consumers' expenditure on livestock products. Consumer expenditure is on the other hand influenced by price elasticity of demand for the output. The price elasticity of demand for livestock products is elastic in view of the discussions made earlier concerning the industry and the availability of close substitutes. This means that a one percentage increase in livestock output leads to a percentage decrease in price that is greater than unity.

As a consequence of the aforementioned problems majority of smallholder farmers earn low and fluctuating incomes from produce sales (Republic of Kenya, 2004). To increase earnings and reduce poverty (see Mwabu *et al.*, 2000; Nafula *et al.*, 2005), productivity in smallholder farms has to increase coupled with market support.

Animal health is essential in increasing livestock productivity. This can be ensured through control of livestock diseases and improved husbandry and feeding regimes (Heyer *et al*., 1976). Commercial feeds of suitable quality and in right quantities are necessary to supplement home-grown fodder and pastures. Unfortunately, commercial feeds are expensive and sometimes out of reach of a majority of small scale livestock farmers. Indeed, commercial animal feeds constitute the largest share of total costs in a well-managed livestock farming enterprise. Due to this and other factors, smallholder farmers use animal feeds sparingly and lose out on output and profit maximization (Heyer and Waweru, 1976).

This paper looks at the potential of livestock farming enterprise to reduce poverty in smallholder farming communities through increased usage of animal feeds, and using Nyeri County as a case study. The rest of the paper is organized as follows: The next section describes materials and methods used in the paper. Section 3 presents and situates a discussion of the regression and simulation results while section 4 concludes the paper.

2.0 Materials and methods

2.1 Data and study area

The data for this study were collected from Nyeri County in Central Province of Kenya. The County is in the eastern highlands and it was purposively selected because it had smallholder farming as the dominant land use activity (Republic of Kenya, 1997, 2002). The area's ecology, climate as well as infrastructure favored agriculture and its farming activities were diverse and intense, providing a suitable case study of issues under investigation. The unit of analysis was the household and the data was collected in face-to-face interviews with farmers.

Sample selection was guided by the National Population and Household Survey framework of the Kenya National Bureau of Statistics (KNBS). The framework is based on the KNBS's National Sample Survey and Evaluation Program (NASSEP IV) frame. NASSEP IV maps the whole country into enumeration areas (EAs) first, and then classifies them into clusters based on population density (see Republic of Kenya, 2007).

In each cluster, a sample of 17 households was systematically selected but in a random fashion to arrive at the desired sample size of 423 households, consistent with Yamane's (1967) and Glenn (2009) sample size formula. The study gathered cross-sectional primary data from the sampled households between July and September 2007.

Table 1 presents some descriptive statistics of variables in the studied area.

Table 1: Sample statistics for variables in Nyeri County

Variable	*Mean*	*Std. Dev.*	*Min.*	*Max.*
Log livestock output, kilogram	2.6	3.42	0	8.9
Capital*10^{-3}, index	0.2	1.86	-2.76	22.07
Labor, days	216.7	183.31	8	1002
Land, hectares	2.6	3.14	.12	23
Animal feeds, kilogram	11785.2	15979.64	0	94900
Age of household head, years	51.3	13.90	16	90
Education of household head, (1=primary…)	1.3	0.78	0	4
Mean animal feeds usage by neighbors, kilogram	14043.2	11217.02	1273.25	57823.63
Distance to the nearest cooperative, kilometer	5.4	7.62	.01	60
Livestock owned (units)				
Cattle	1.82	1.3	0	10
Sheep	4.4	6.0	0	35
Goats	3.6	5.98	0	45
Livestock output in kilograms per annum				
Chicken meat	10	17	0	200
Milk	1953	1534	40	7301
Eggs	1238	1533	60	6840
Livestock and output prices (Ksh per unit)				
Cow	18165	9188	5000	60000
Sheep	2266	1082	1000	5000
Goat	2246	1113	1000	5000

Chicken	236	90	100	500
Litre of milk	15.4	1.79	12	20
Egg	7.5	0.9	6	8
Sample size	423	423	423	423

Average cow holding ranged from 1.27 in the municipality to 14.5 in the drier pastoral areas. In the pastoral areas, Zebu beef cattle were the most common while in the wetter areas crosses of imported dairy breeds with the local Zebu were the most common. Dairy goats were making entry into the County in view of rising demand for milk in a situation of declining land holding. Virtually every rural household kept at least one livestock type especially the small stocks to cater for household needs. Chicken was the most common livestock.

2.2 Analytical issues

A small farm is a production unit. The farmer as a producer combines various inputs in some technological manner so as to produce output. If the production is successful, the farmer reaps the gains and if not, he bears the loss. Thus, the farmer is an entrepreneur in so far as he makes production decisions and takes risks by engaging in production.

Suppose that the farmer is an economic agent who chooses levels of inputs that will maximize profits in a production activity. Suppose further that the farmer uses only three inputs namely, labor, L (measured in person-days), capital, K (an index of various types of equipments) and materials, M (measured in quantity consumed per production period). If the inputs are contracted in a competitive market the farmer can buy all he wants at the prevailing wage (w), rental rate (v) and unit price (m). Under these simplifying assumptions and following Varian (1984) and Debertin (1986) , the farmer's production function is

$$Q = f(L, K, M) \ldots\ldots\ldots\ldots \quad (1)$$

while his cost function can be written as

$$C = wL + rK + mM \ldots\ldots\ldots\ldots \quad (2)$$

The farmer’s augmented objective function can be written as:

$$\text{Maximize } \pi = P.Q - wL - rK - mM \ldots\ldots\ldots \quad (3)$$

The farmer can increase his profits as long as the addition to his revenue from employment of an additional input exceeds its cost.

The first order condition for profit maximization requires that application of each input be increased up to the point at which the value of its marginal product equals its price. Solving the first order partial derivatives of the normal equations yields the optimal levels of factor inputs, L*, K* and M*. These are the input demand functions. At these levels, the farmer's profits are maximized and cannot be improved upon by changing the amount of any of the inputs. That is, given the optimal input demands, an optimal farm output is produced.

From equations (1) to (3), the direct linkage between input demands and the level of farm output produced can be observed. It should also be appreciated that output supply function Q(P) can directly be obtained from equation (3) using Hotelling's derivative property of the profit function, i.e., by differentiating the profit function with respect to output price, P. Similarly, input demands can be obtained by differentiating the profit function with respect to input prices.

A farmer's production function may also be influenced by a vector of other covariates. Available literature suggests that in addition to traditional factor inputs, a host of other factors that include but not limited to household characteristics, availability of extension services and input usage by neighbors augment farm productivity in smallholder agriculture (Heyer and Waweru, 1976; Feder *et al*., 1985; Singh, Squire and Strauss, 1986; Randrianarisoa, 2001; Gathiaka, 2010, 2012). Expanding equation (1) to include the influence of additional covariates, the general production function for a smallholder livestock farmer can be expressed as a structural equation of the form:

$$Q = f\,(L, K, Ha, Af, W, Ed, Age, Ext, N, ...) \ldots\ldots\ldots\ldots\ldots \quad (4)$$

where, Q = livestock output; L = total labor input; K = total capital input; Ha = farm size; Af = animal feeds; W = rainfall; Ed = education level of the head; Age =age of the farmer; Ext = extension services; and N = neighborhood variables.

It is important to note that some inputs applied to a farm, e.g., animal feeds could be endogenous because of several reasons. First, the measurement of the input could be with some margin of error, and the error could be captured in the disturbance term of a production model. The disturbance term and the erroneously measured input could in some circumstances be correlated. Secondly, usage of an input could be influenced by unobserved variables that are omitted in a production function but captured in the disturbance term. The omission makes the input and the disturbance term correlated. Lastly, an input and the output could be simultaneously determined. Simultaneity makes an input endogenous.

Animal feeds usage in a farm is, for example, determined by a farmer (see Akwasi, 2010). The quantities used may be influenced by unobserved variables that are omitted in the production model. The influence of these other variables is captured in the disturbance term. To this extent, the correlation between animal feeds and the disturbance term is not zero and animal feeds variable is thus endogenous. In addition, the farmer may report the amounts of animal feeds that he applies on the farm with error. The error is captured in the disturbance term and the correlation between animal feeds and the disturbance term is not zero making animal feeds endogenous.

To assess the impact of animal feeds on output taking into account the problem of endogeneity, animal feeds has to be instrumented when estimating parameters of a production function. The instrumental variable has to have the property that it affects demand for animal feeds without influencing farm output. A good instrument is uncorrelated with the error term and only partially correlated with the variable it stands for once other exogenous variables are netted out (Greene, 1997; Wooldridge 2002).

A farmer may also have special natural ability in production which makes his yields higher for a given level of inputs. Natural ability is unobserved and not easily captured in a model. Such unobserved heterogeneity is controlled for using instrumental variables methods. The method of instrumental variables is illustrated in the reduced equation (5). The equation shows the predicted demand for animal feeds Af^{*}. Af^{*} is determined by all the variables of the above livestock output function and an instrumental variable V as shown below:

$Af^{*} = f$ (L, K, Ha, W, Ed, Age, Ext, N, …V) …………........... (5)

where, Af^{*} = predicted demand for animal feeds, V = instrument for animal feeds (e.g., distance to a cooperative society from where animal feeds are sourced). Other variables are as earlier defined.

Af_t^{*}, the predicted demand for animal feeds should replace the actual measure of animal feeds (Af) in the estimation of farm output production in equation (4) above (see Greene, 1997; Wooldridge 2002). The instrumental variables method is used here to deal with problems that may be posed by the endogenous input in the estimation of the production function. If endogeneity is not controlled for, the estimated parameters will be biased and inconsistent.

The estimates of the parameters of livestock output in equation (4) show the returns to the inputs used in production. From these estimates the response of output to changes in the levels of input application can be calculated. The calculated estimates show the elasticity of output to changes in input application at the farm level. They are important in simulating output using input changes as seen later in the paper. In the next section, we present and discuss estimation results of equations (4) and (5) starting with the latter, the predicted demand for animal feeds.

3.0 Results and discussions

3.1 Demand For Animal Feeds

Parameter estimates of demand for animal feeds are presented in Table 2. In the model, the dependent variable was animal feeds in kilograms. The model postulated demand for animal feeds to be determined by factor inputs, characteristics of a farmer, characteristics of neighbors and distance to the nearest cooperative society from where animal feeds are mainly sourced. The effect of distance to the nearest cooperative society on demand was assumed to be non-linear, and this made it necessary to consider demand effects of distance together with its square term. The mean of animal feeds usage by neighbors within a village captured social interactions among farmers as they affect animal feeds usage in an individual farm.

The same model was also estimated separating the factor inputs in a bid to control for multicollinearity among them. Results showed that multicollinearity was not a problem in the specified model.

Table 2: First stage regression – demand for animal feeds (*t*-statistics in parentheses)

Variables	*OLS Estimates*
Factor Inputs	
Capital, index	1673.133(4.06)
Labor, person days	15.564(3.82)
Land, hectares	-297.623(1.20)
Farmer and Neighborhood Characteristics	
Age, years	589.671(1.76)
Age^2	-5.140(1.65)
Education, level	-735.273(0.73)
Mean of animal feeds used by neighbors, kilograms	0.231(3.20)
Exclusion Restrictions	
Distance to a cooperative society, kilometers	-386.073(1.83)

Distance to a cooperative squared	16.349(3.60)
Constant	-8170.64(0.91)
R^2	0.192
F-statistic [*p*-value]	10.90[0. 000]
Root MSE	14521
Observations	423

The parameter estimates in Table 2 showed that capital, labor, mean of animal feeds usage by neighbors, and distance to the nearest cooperative society were the main determinants of demand for animal feeds. While the influence of capital, labor and neighborhood variables were positive, the influence of distance to the nearest cooperative society was negative. Thus, animal feeds were widely used by the wealthier farmers who also engaged hired labor, and by farmers nearer to cooperative societies.

A unit increase in household capital was found to raise demand for animal feeds by 1,673 kilograms. Capital may be a proxy for household wealth. Wealthy households were able to adopt better animal husbandry practices, including use of more animal feeds. Labor employment was found to be associated with higher demand for animal feeds. As labor employment increased by one person-day, demand for animal feeds increased by 18 kilograms.

Farmers far off from a cooperative society had lower demand for animal feeds. The cooperative society was a major source of farm inputs in the studied area so that where it was located far away from farmers, transportation costs discouraged usage of the inputs. For every kilometer increase in distance to a cooperative society, demand for animal feeds dropped by 130 kilograms.

Age of the household head was associated with rising demand for animal feeds unlike his education level. The negative sign of the coefficient on education suggested that highly educated farmers used less animal feeds probably because they did not engage much in livestock activity. Educated farmers may have shunned livestock farming to avoid conflict with their non-farming activities.

When average animal feeds usage by neighbors within a village increased by one kilogram, demand for feeds by an individual farmer within the village was indicated to rise by over 0.2 kilograms. This was evidence of positive social externalities in animal feeds usage in smallholder agriculture. Increased usage of animal feeds by some farmers in a village encouraged other livestock farmers within the village to increase their own usage of animal feeds. This suggested that well-off villages that engaged in livestock farming drew increasing returns due to wider usage of animal feeds.

Poor villages needed to increase usage of animal feeds so as to increase output and revenue from livestock farming. We sought to investigate whether the returns to animal feeds justified increased expenditure on this input by poor smallholder farmers. In the next section, we discuss returns to the inputs into livestock farming paying special attention to animal feeds.

3.2 Returns To Inputs In Livestock Farming

Table 3 presents estimates of the livestock output model in equation (4), using animal feeds as the treatment variable. The OLS estimates show the returns to capital, labor and animal feeds are statistically significant at the 5 percent level. Since animal feeds could be endogenous in a livestock output model, instrumental variable (IV) coefficients were also estimated. The IV-2SLS estimates were the second stage regression results of the model (equation 5) shown in Table 2. In recognition of the possible problems that could have arisen from self-reported recall data, control function coefficients were also estimated. In the IV-2SLS and control function estimates, only the return to capital was found to be statistically significant at the 5 percent level. At a slightly lower level of precision, return to labor was also statistically significant.

Table 3: Livestock output function (dependent variable is log of livestock output), *t*-statistics in parentheses

Variables	*OLS Estimates*	*IV-2SLS Estimates*	*Control Function Estimates*
Factor Inputs			
Capital, index	.273(3.03)	.292(2.42)	.292(2.45)
Labor*10^{-1}, person days	.002(1.95)	.002(1.62)	.002(1.79)
Land, hectares	.071(1.34)	.069(1.27)	.060(1.11)
Animal feeds*10^{-3}, kg	.060(5.83)	.049(1.04)	.057(1.22)
Farmer and Neighborhood Characteristics			
Age, years	-.013(0.18)	-.007(0.09)	.018(0.23)
Age^2*10^{-2}	.012(0.17)	.007(0.09)	-.015(0.21)
Education, level	.010(0.05)	.005(0.02)	.006(0.03)
Mean animal feeds usage by neighbors*10^{-3}, kg	.016(1.07)	.019(0.96)	.021(1.11)
Controls for Unobservables			
Reduced form animal feeds residual*10^{-3}	-	.011(0.23)	.049(0.97)
Animal feeds*reduced-form residual*10^{-8}	-	-	-.106(2.75)
Constant	1.438(0.75)	1.332(0.68)	.746(0.38)
R^2	0.183	0.181	0.198
F-statistic [*p*-value]	11.59[0.000]	7.46[0.000]	10.16[0.000]
Root MSE	3.116	3.12	3.095
Observations	423	423	423

Since the parameter of animal feeds variable lost statistical significance in the IV-2SLS estimation, it confirmed that animal feeds variable was actually endogenous in the model and pointed to the weakness of OLS estimation method.

Animal feeds was not a significant variable in explaining livestock output. This was because in smallholder agriculture only small amounts of the input are used in a farm. Usage of small quantities of animal feeds denied the animals desirable nutrients and minerals, and this caused their output to be low. Low output of livestock products had negative consequences on incomes and welfare of the livestock farmers. Later on in the paper we explore whether increasing animal feeds usage at the farm level can reduce poverty in the farming households.

Reading from the control function (CF) estimates, capital and labor were the only variables with statistically significant parameter estimates in explaining livestock output. Thus, increasing the inputs of labor and capital increased livestock output noticeably. In livestock farming, 10 person days engaged in livestock activity increased livestock output by 0.002 per cent while one unit increase in capital raised output by 0.3 per cent.

From these results, livestock output elasticity with respect to factor inputs was calculated. Table 4 presents elasticities of livestock output with respect to factor inputs.

Table 4: Elasticity of livestock output with respect to factor inputs (*t*-statistics in parentheses)

Variable	*Elasticity*
Capital, index	0.13(3.68)
Labor, person days*10^{-2}	.087(2.53)
Land, hectares	.047(2.35)
Animal feeds*10^{-3}, kg	.025(6.04)

From the foregoing discussion of demand for animal feeds, returns to factor inputs and elasticity of livestock output to input changes, livestock farming does not appear to be a likely tool for poverty reduction. Nevertheless, we might ask the question whether modernizing the enterprise of livestock farming by especially increasing usage of animal feeds at the farm level can change the situation. The effects of increasing animal feeds usage on farm revenue and poverty reduction are shown in the next section.

3.3 Simulated effects of increased animal feeds usage on farm revenue and poverty gap

Table 5 presents simulated results of increasing animal feeds usage on livestock output. Starting with a base livestock output of 304,373[2] kilograms and livestock output elasticity with respect to animal feeds of 0.000025 (Table 4 above), an increase in animal feeds usage by say, 3 percent, would increase livestock output by 1.9 percent or 5,844 kilograms. Starting with a base price of Ksh 27[3] per kilogram of livestock output, if all the 5,844 kilograms of livestock output were put on the market, sales competition among farmers would drive the price down to Ksh 20.60. At the new price, revenue to farmers would

[2] The figures are calculated from data collected from Nyeri in 2007
[3] Weighted mean price of milk, eggs and chicken in Nyeri in 2007

increase by Ksh 120,386.40. But this increase is not optimal since revenue can be increased further through higher usage of animal feeds as shown in Table 5.

The optimal increase in animal feeds usage is estimated at 7 percent. With this increase, output would increase by 4.48 percent or by 13,636 kilograms. Given an inverse absolute price elasticity of demand for livestock output of 0.46[4], an annual increase of 13,636 kilograms in livestock output would cause the price to drop by 56 percent[5] to settle at Ksh 11.90 per kilogram of livestock output. At the new price, annual revenue to the farmers would increase by Ksh 162, 268. Considering a population of 1,595 adult equivalents in Nyeri County, the increase in revenue would be only Ksh 101.7 per adult equivalent.

Table 5: Scenarios of increasing animal feeds usage on livestock output and farm revenue

	Scene 1	*Scene 2*	*Scene 3*	*Scene 4*
Base Livestock output in kilograms	304,373	304,373	304,373	304,373
Percentage increase in animal feeds usage	3%	5%	7%	10%
Percentage increase in livestock output	1.9	3.2	4.48	6.4
Change in output in kilograms	5,844	9,740	13,636	19,480
Total livestock output after the increase in animal feeds, kilograms	310,217	314,113	318,009	323,853
Per capita increase in livestock output per adult equivalent in kilograms	3.7	6	8.55	12
Base price per 1 kilogram in Ksh	27	27	27	27
New price per 1 kilogram in Ksh	20.6	16.2	11.9	5.50
Farm revenue due to an increase in livestock output per adult equivalent (Ksh)	76.2	97.2	101.7	67

Thus, if usage of animal feeds in the County were to rise by 7 percent on average, annual gains from sales of the extra livestock output would be equal to Ksh 102 for every adult equivalent in the County. This amount can bridge the poverty gap in the area that is estimated at 11.7 (Republic of Kenya, 2007) by 4.6 percent. Moreover, additional output would become available to consumers at lower prices, raising their welfare.

[4] The inverse price elasticity of demand for livestock products calculated from the Nyeri data is 0.46.

[5] Given inverse elasticity of demand, Ø= $\frac{dp}{dq}.\frac{q}{p}$, substituting figures, 0.461= $\frac{dp}{13636}.\frac{304373}{27}$ and working out the equation gives $dp = .56$

An increase in animal feeds above 10 percent would collapse the market price for livestock products in the County. The market for livestock products is fragile.

4.0. Conclusion

Smallholder livestock farming could be an avenue for poverty reduction in smallholder agriculture, but it has challenges. The market for livestock products is volatile and this denies farmers increasing revenues for their produce during wet seasons when supply is highest. Without adequate earnings, livestock farmers are unable to purchase inputs that are known to enhance productivity in a livestock enterprise. Usage of animal feeds in smallholder farms is currently low despite its profitability. An increase in usage of this input can significantly increase livestock productivity and farm incomes.

In view of the volatility in the market of livestock products, animal feeds usage in smallholder farms can only be increased concomitantly with market safeguards if farmers are to realize higher incomes and reduce poverty. To reap maximum benefits from the resultant increase in output, livestock farmers have to adopt new marketing strategies. They must organize into cooperative societies.

Cooperative societies would assist farmers to market their produce far and wide including selling to the more lucrative urban and export markets.

Through the societies farmers can process perishable products such as milk, thereby reducing its perishability and lengthening its shelf life. Milk surpluses can be processed and stocked for sale during dry seasons. This would have the additional benefit of stabilizing the volatile prices of milk. Cooperative societies in general can play an important role in stabilizing the market of agricultural products.

Processing also facilitates diversification of final products and more importantly, conversion of low priced products (e.g., milk) into highly priced products (e.g., yoghurt). This value addition gives farmers higher incomes for their produce.

In addition, cooperative societies could help farmers negotiate for lower input prices. Since cooperatives buy inputs such as grains and animal feeds in bulk, it is easier for them to extract huge discounts from the sellers. Lower input prices can encourage inputs usage besides their income effects.

With more cooperative societies closer to the farmers, animal feeds usage both at the farm and village levels would be higher. As distances to the source of inputs decrease, demand for the inputs was noted to increase.

Cooperative societies help poor farmers to pool resources together, enabling them to realize scale economies. As their numbers increase, farmers become ‘visible’ and their demands for better infrastructure from the government, or credit facilities from banks receive attention, unlike when they approach these issues as individuals.

At the moment, cooperative societies that serve livestock farmers in the study area are few and far between. Most farmers sell their produce of milk, eggs and chicken to middlemen or consumers in the nearest market centers. These markets are shallow and offer low prices for farm produce. This situation can change significantly if farmers were to access the services of cooperative societies.

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