Markets and livestock in the coming decades: Implications for smallholder highland producers[1]

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Introduction

It is well recognized that people living in highland regions depend particularly on livestock for their livelihoods. Where crop production is feasible, livestock is an essential component of farming systems and provide food, traction, manure, income, fiber and perform other social and economic functions. Where extremes of climate and terrain make crop production especially difficult, livestock can often live and flourish on available resources, and provide livelihoods. What is less well recognized is the importance of livestock markets, and also the special constraints that such markets face in highland and mountain areas to further livestock's contribution to livelihoods.

This paper reviews recent research to first present a picture of coming trends in livestock product consumption and production in developing countries in general, and derives some market implications of those for smallholders in the highlands. Evidence is also presented as to the linkages between livestock, agricultural intensification, and markets. Finally, several highland case studies are presented that show in detail some of the major market constraints facing highland livestock producers.

The continuing Livestock Revolution

Clear evidence is now available that smallholder livestock producers in developing countries are being presented with growing market opportunities. A recent study by Delgado *et al.* (1999) examined the trends for livestock demand and production to 2020, with a focus on developing countries. Based on a global food model, they predict where and to what degree demand for livestock products will grow, and simultaneously predict where the increased production needed to meet that demand will occur.[2]

The projected changes are dramatic. Particularly because of increases in per capita income in Asia and elsewhere in developing countries, but also due to growing human populations and urbanization, consumption of animal products will increase significantly in all developing countries by 2020. Consumption of meat and milk is predicted to grow by about 50% in the period from 1993 to 2020 in developing countries, to some 30 kg/capita and 62 kg/capita, respectively (Table 1). Much of the growth in meat consumption will occur in pork and poultry, although beef consumption per capita is expected to grow by more than 30% as well.

Further, significant growth in animal product consumption can be expected to occur in all regions of the developing world (Table 2). The largest volume increases are expected in China where total milk and meat consumption will more than double. Overall, milk and meat consumption in developing countries is projected to grow at a rate of about 3% annually, with the highest

[2] The IMPACT model is a global food model of 18 commodities including 7 livestock commodities, covering 37 separate regions/countries, and with annual iterations to 2020. It incorporated expected growth in population and income, and changes in productivity (Delgado et al, ,1999).

rate of growth in Sub-Saharan Africa (3.5%), although from a low base. In sharp contrast, consumption in developed countries is expected to change hardly at all. This phenomenon is centered entirely in the developing world.

These dramatic changes, which are already well on their way, have been described as the Livestock Revolution (Delgado et al, 1999), which in value terms is larger than the Green Revolution of the 1960's and 70's. From the point of view of smallholder producers, however, the important question remains: where will the increased production needed to meet this demand take place and whether smallholder livestock producers will be able to participate in this market opportunity?

The answer is that increased production is expected to occur generally in the same areas where the increased demand is expressed, rather than be imported. This simply follows the current pattern: 10% or less of value of livestock production is traded internationally (FAOSTAT, 1998). In spite of the public attention sometimes given to livestock product trade issues, livestock products are not easily traded, requiring extensive transformation or high cost to preserve and transport, after which they may not share the level of quality as local fresh products. Thus, the model predicts that countries deficit in livestock products will generally import feed rather than meat & milk, leading to rapid increases in feed grain imports in some areas (Table 3).[3]

As a consequence, livestock production in developing countries will increase approximately on a par with consumption. By 2020, developing countries will produce some 60% of all meat and 52% of all milk globally, up from some 47% and 32%, respectively, in 1993. This increased production is expected to put new stress on extensive livestock production systems and those relying on peri-urban grazing, and creates the potential for concentration of production.

The Livestock Revolution also means, however, new market opportunities for smallholder livestock producers. Important constraints remain however, that will impede the ability of smallholder to participate, including:

- Small scale of production and marketed output implies low bargaining power, and inability to capture economies of scale in marketing
- Poor access to livestock services and credit
- Policy that favor capital-intensive livestock production
- The growing commercialization of livestock production, particularly through industrial production of poultry and pork

In the highlands, these constraints are likely to be even more severe. Will highland livestock producers and communities be able to participate in the Livestock Revolution?

[3] In spite of increased use of grains for feed, the IMPACT model predicts that grain prices will not rise significantly, and would remain in real terms below levels seen in the 1980's. This is due to expected continued productivity increases (Delgado et al.,1999).

The link between livestock and people

In considering the future of livestock markets and their likely impact on highland communities, it is useful to look at patterns of linkages between people and the livestock they keep. In short, not only will production growth occur in the same areas as demand growth at the global level, but also locally, market constraints and other factors lead to livestock living near to people.

An important indicator of potential market constraints to livestock products can be seen in the spatial link between human and livestock population densities. Historically, the evolution of agricultural production systems shows that there was a positive relationship between human and livestock population densities – areas with high human population densities also had high livestock population densities. A number of previous and recent studies at country, region and global level confirmed this historical pattern (Mukherjee, 1938; Jabbar and Green, 1983; Wint and Bourn, 1994; Sere and Steinfeld, 1996; Slingenbergh and Wint, 1997; Lapar, 2000). Wint and Bourn found that in Sub-Saharan Africa, in areas <500 mm rainfall, 70-90% of that ruminants occur in rural systems.[4] The remaining animals are in villages or within settlements. However, as rainfall increases, the proportion of animals in rural areas falls, to 50-60% in areas of 500-2000 mm, and to 10-15% in the wettest areas. This seems generally to occur because as rainfall is more plentiful, the availability of adequate feed resources allows the transport of feed and fodder into urban areas. Livestock are then kept as close as possible to demand centers, in order to reduce constraints in marketing livestock products. Given that many highland areas also experience relatively higher rainfall, these same trends could occur in those settings. Sere and Steinfeld found that among the different agro-ecological zones, highlands have the highest livestock population densities and sometimes very high human population densities. Slingenbergh and Wint found in their global study that spatially, livestock population densities occur at a rate approximately double that of the human population density. Approximately the same results were found in SSA, and a slightly lower level of relationship in Asia.

This positive relationship between human and livestock population densities normally occurs until urbanization and industrialization lead to a steady decline in the rural population depending on agriculture. However, where urbanization is not accompanied by adequate development of market infrastructure to connect rural producers and urban consumers, livestock production continues in urban/peri-urban areas. For example, in the mid 19th century, most European cities depended on urban/peri-urban dairies for much of their milk and beef. By the turn of the century, these urban/peri-urban dairies disappeared because of health regulations, improved infrastructure, and economies of scale leading to larger production units, which in turn required more land (Phelan and Henriksen, 1995). In the newly emerging economies of East and Southeast Asia, a combination of rapid income growth, urbanization and population growth led to a rapid increase in the demand for livestock products, particularly meat and

[4] These figures refer to % of ruminant biomass, not numbers of animals.

meat products. Traditional rural livestock production systems were slow to respond to these demands, increasing imports and the role of urban/peri-urban industrial production systems, particularly for non-ruminant livestock. Lack of adequate infrastructure, high transport cost from distant areas and lack of regulations on the one hand and supporting trade, price and subsidy policies of different governments on the other, have led to the establishment of such production enterprises in urban/peri-urban areas. A recent study has identified these concentrated livestock production systems in these countries as one of the ' hot spots of livestock-environment interactions' (de Haan et al. undated).

Markets are particularly susceptible to infrastructure, which in highlands is expensive to build and maintain, and is liable to disruption, so that such investment is often uneconomic even with moderate to high population densities. Yet without proper market infrastructure, highland livestock producers are unlikely to be able to benefit form the national and global market opportunities for their products.

Smallholder access to markets: example of dairy

Dairy is a major enterprise in the highlands because of its suitable climate to raise animals with lesser difficulties than in the humid and arid/semi-arid areas. On a global basis, highlands produce 25 kg milk per ha compared to 17 kg in arid/semi-arid and 10 kg in the humid/sub-humid areas. Milk output per capita is respectively 34, 49 and 8 kg in these ecozones (Sere and Steinfeld, 1996). For example, dairy product consumption in SSA is expected to grow by 3.8 – 4% annually between 1993 and 2020 and domestic production has the potential to meet this demand and generate additional income, employment. However, smallholders will benefit only if they can participate in the market, which will be globally related and influenced. Some producers sell home processed products due to lack of access to fluid milk market in distant urban areas.

Several barriers remain to smallholder participation in dairy production.
Prominent among them are :

Availability and cost of animals: without better quality animals that offer potentially higher milk yields, the ability and probability of market participation reduces significantly as small quantities of milk from local cows are inadequate to justify the investment in time and labor necessary to reach the market. But better quality animals are not always easily available due to lack of breeding stock production programs and the cost may be beyond the reach of many smallholders. Credit can relax such constraints, but given the criteria usually used for judging credit worthiness, many smallholders are left out of the formal credit market. Identification of farmers with real credit constraint and extending credit to such farmers has a much higher production and market participation effect than simply extending credit to those who meet traditional criteria such as ability to provide collateral and apparent repayment capacity (Freeman et al., 1998).

Seasonal feed availability & quality: inadequacy and poor quality of feeds is a major constraint for livestock in the highlands, particularly for dairy animal production. When improved dairy animals are raised, this constraint limits the milk yield potential of such animals; consequently, the volume of milk entering the market also falls short of the potential.

Market and spatial factors: Traditional smallholder livestock producers are generally scattered in rural areas often characterized by inadequate access to roads and transportation facilities. By raising transaction costs, this limits market participation in two principal ways. First, milk is a bulky perishable commodity, so needs quick disposal. Distance, time and effort required to reach market and associated risks of spoilage thus become important factors determining producer participation in the market. Second, inadequate access to inputs and services (veterinary services, drugs, artificial insemination, feeds etc) serve as a disincentive to adopt improved dairy cows, thus reducing dairy market participation (Staal et al., 1997).

Regulations restricting participation: In some countries governments have established dairy processing and milk collection infrastructure to give small producers access to a stable market outlet for their products. While such parastatal organizations have initially played a positive role in expanding smallholder dairy production, in time they also became a principal source of disincentive for further expansion because of their monopoly behavior and resulting inefficiency. The informal milk markets that emerge to bypass these inefficiencies offer less reliability, and often are limited in scale. Policies towards marketing and institutional roles thus affect smallholder livestock access to reliable, supportive markets (Staal et al., 1997).

Constraints to livestock market participation : two case studies

Case 1: Smallholder dairy in highland Kenya (1500-2500 m)

Kenya is one of the few success stories for smallholder dairy development in the African continent, particularly in the highlands region. European settlers originally started medium to large scale dairy farms with exotic and cross breeds to meet the growing urban markets and the rapidly expanding tourist industry. Beginning in the 1950s, crossbred dairy cattle began to be acquired by indigenous smallholder farmer. These were eventually supported by government-established milk processing facilities, milk collection centers, and a federation of dairy co-operatives of producers, called Kenya Cooperative Creameries (KCC). These cooperatives played an important role in smallholder dairy development during the 1970s and 1980s, such that smallholders now supply about 80% of the milk marketed nationally. However, the KCC had a monopoly on the purchase of fluid milk from local cooperatives and on all urban milk sales, using prices set by the government. By the early 1990s, these policies resulted in a high producer-consumer price spread, leading to declines in milk deliveries to KCC as producers diverted milk to private informal traders at higher prices. The 1992 deregulation of the milk market followed a similar liberalization in veterinary and AI services. These led to a dramatic change in the nature and extent of market participation (Table 4). There has been a large increase in the rate of unregulated raw milk market and a decrease in the relative share of sales to KCC outlets; and rural dairy co-operatives have started providing vet and AI services alongside private sector. There was also observed significant rise in real prices received by producers and an emergence of a price gradient by distance from urban centers: the further away the milk producing farm, the lower the price they receive.

In order to more systematically verify how spatial, household resource, and agro-ecological factors in the highlands affect market access (measured as farm gate milk price) and ability to take up dairy technology (measured as probability of having a dairy cow), a detailed study was conducted combining farm survey and GIS-derived variables in an econometric analysis (Staal et al., 1999). A random survey was conducted among 1,389 households in central highland of Kenya, about half of whom were small dairy farms who depend on both formal and informal markets. In the latter the farm-gate milk price is 10% higher, but more risky as seasonal demands vary and informal market agents sometimes fail to pay. Each household was geo-referenced using GPS units. GIS tools were then used to derive least-travel-time distances from each farm by road to urban areas and milk market points, by road type. Additional GIS data on rainfall, temperature and human population density were also included to determine factors influencing adoption potential of improved dairy cow.

The results of this analysis confirm that there is a milk price gradient by distance from urban centers: the further the distance, the lower the price in both formal and informal markets, although the effect is much stronger in the latter (Table 5 and Figure 1). Per kilometer of tarmac from the largest city, the negative effect on farm-gate milk price is about double in the informal market. This difference does not necessarily suggest, however, that informal markets operate less efficiently per kilometer than formal markets, only that informal market prices paid to farmers more explicitly reflect actual transport costs and associated risks. That is because the formal market tends to offer uniform prices at the main collection centers, regardless of distance.

The other important difference between the formal and informal market results is seen in the effect of dairy herd size on farm-gate price (Table 5). In the formal market, a larger herd (and so more milk delivered) leads to higher prices; in the informal market the price effect is significantly negative and large. This can be seen as a clear indication of the inability of the informal market to capture economies of scale in milk transport due to technology used, but perhaps also to existing government policies. Currently, if traders increase their scale of operation from bicycles to pickups, they face increased risk of harassment and fines from law enforcement, as informal milk trade for sale of raw milk in urban areas is illegal

The results of a profit analysis of dairy cattle adoption are shown in Table 6. The variables with significant and positive effect on the probability of dairy cattle adoption are years of education, total household land, availability of veterinarian and formal market locally, and agro-climate. The human capital parameters are highly significant, and indicate about a 1% increase in probability of adoption with 1 additional year of formal education. The total land parameter is weakly significant while rainfall and temperature are strongly positive, indicating that land size is less important than agro-climatic potential. The local market and services access parameters are very significant and large. An increase of 1% of the proportion of local sales to formal markets is associated with a more than 3% increase in the probability of adoption, which can be attributed to greater reliability and lower risks in milk marketing, and so reduced risks of adoption. The availability of veterinarian can be similarly expected to reduce risks, and so has a large positive effect. Finally, distances by road to urban centers also have a significant impact. These last three variables underline the importance of access to markets and services for this case of highland smallholder dairying. The strong positive effect of agro-climate has implication for highlands systems, which generally have relatively higher levels of rainfall and lower temperature, and underline significant comparative technical advantage of production for major type of livestock products, including dairy.

Case study 2: Smallholder dairy in highland Ethiopia (~2000 m)

Mixed smallholder farms predominate in the highlands of Ethiopia. The large cattle population, mostly indigenous Zebu, perform many functions including providing traction, manure and milk and milk products. However, sale of fluid milk is insignificant in the rural areas outside the Addis Ababa milk shed, which covers 120 km radius, principally along the main roads. Dairy is a major activity in Addis Ababa city and its surrounding areas and most of the country's crossbred dairy animals are located here. The government has established a Dairy Development Enterprise (DDE) to provide market and other physical and service facilities to promote dairy development. The DDE has established a processing plant in Addis Ababa and milk collection points along the main roads to provide a stable market outlet for producers, and veterinary, AI services and inputs. There are also milk producers' cooperatives, which provide selected services to its members, but its activity is primarily concentrated in the Addis Ababa city. The DDE collects milk at pre-fixed prices, which has remained unchanged for several years though prices in the informal market vary both between seasons and between years. The nature and extent of market participation by urban/peri-urban and rural producers is limited by distance and road infrastructure (Table 5).

In spite of the support from the DDE, about 88% of urban milk is handled by the informal market and nearly all rural milk is processed and sold in the informal market. Prices vary by type of outlet and location (Table 6). In general, every other outlet paid a higher price than the DDE in both urban and per-urban areas. This rather rigid marketing environment within the framework of the overall command economy run by the previous government contributed to the slow and less than expected growth in the dairy industry. The gradual liberalization of the economy by the present government has also included some reform in the dairy sector. Recent reform measures have allowed formal private milk traders and cooperative farmer milk groups to appear alongside the DDE. It is too early to assess the full impact of these reform measures and emerging institutions on the dairy industry and the extent of farmer participation in market.

However, policy reform may not be enough to improve market access for smallholder highland dairy farmers. A study among a stratified sample of 144 farms in an area where milk groups have emerged after new regulations, shows that transaction costs is a major determinant of probability of market participation by dairy farmers. Only 15% of the sample sold milk to the milk groups at any time during the five month survey period, and market participation (i.e., sales of milk to milk groups) was significantly determined by marketable surplus and distance. Distance is measured by time to transport milk to the group's purchase point, which serves as a proxy for an important component of transaction costs. It was estimated that current non-participants are likely to participate if, other things being equal, they can increase marketable surplus by 9.8 liters, have either 2-3 cross-bred cows or 6 local cows, or have about 10 extension visits per year or if their return journey to the market could be reduced by about 2 hours (Holloway et al.,2000). Therefore, transaction costs determined by market infrastructure seems to be a major constraint to smallholder participation in dairy marketing and adoption of improved cows to produce more milk.

Conclusions

Global trends in livestock demand and production point clearly to strong growth potential, especially in the developing countries. The question is whether smallholder mixed farmers will be able to compete with growing industrial systems and participate in the domestic and global market, and what are the particular constraints facing those in the highlands. The constraints that policy-makers will need to address include small scale of production and marketed output, poor access to livestock services and credit, policies that favor capital-intensive livestock production, and the growing commercialization of livestock production. On means of addressing these constraints may be through farmer organizations that allow better bargaining power, and vertical integration of activities. Other factors favor smallholder livestock production, particularly through the greater nutrient cycling possibilities in mixed farms, and consequent increased returns to livestock production.

Broad regional studies and case studies show that livestock production is particularly constrained by market and spatial factors. In highland and mountain regions these constraints are likely to be relatively even greater due to high costs of infrastructure, and risks of disruption. On the other hand, in some cases, highlands offer high potential because of existing mature mixed farming systems, high human and livestock population densities and the climatic advantage to raise better productive dairy animals, e.g. crossbred cows. Selected case studies show that the primary constraints to their participation are remnants of restrictive policies and regulations, high transaction costs due to poor infrastructure and information system and poorly developed markets for input and outputs. These case studies also show that recent reforms have eased some of these constraints with good results for both producers and consumers. Further reform and investment in supporting infrastructure, including farmer group development, can help provide good growing opportunities for smallholder livestock producers in highlands systems.

Table 1. Per capita consumption of livestock products in developing Countries

Commodity	1993	2020
	Kg/capita/year	
Beef	5	7
Pork	9	13
Poultry	5	8
Meat	21	30
Milk	40	62

Adapted from Delgado et al, 1999.

Table 2. Projected growth in total milk and meat consumption for selected regions, 1993 to 2020

	Meat			Milk		
Region	**1993**	**2020**	**Growth rate**	**1993**	**2020**	**Growth rate**
	Million MT/yr		%/yr	Million MT/yr		%/yr
China	38	85	3.0	7	17	2.8
India	4	8	2.9	52	160	2.9
Latin America	21	39	2.3	46	77	2.3
Sub-Saharan Africa	5	12	3.5	14	31	3.5
World	184	303	1.8	412	654	1.7

Adapted from Delgado et al, 1999, p. 24

Table 3. Projected growth in total cereal use as feed

Region	1993	2020	Growth rate
	Million MT/yr		%/yr
China	84	178	3.4
India	3	14	5.0
Latin America	55	92	2.0
Sub-Saharan Africa	3	5	3.5
Developing World	194	409	2.8
Developed World	442	519	0.6

Adapted from Delgado et al, 1999, p. 26

Table 4: Pre and post-reform status of dairy farmers' co-operatives in three districts in highland Kenya

	1990	1995	% Change
Registered members	58,428	83,751	43
Active members	22,078	35,248	60
Milk Sales (000 Lt)			
Retail outlet	8,702	17,785	104
KCC	17,712	15,295	14
Middlemen	4,848	5,972	23
Private processors	486	1,499	208
Total	***31,748***	***40,551***	***28***
Numbers of DFCS providing service			
Milk marketing	27	30	11
Sale of Vet drugs	9	13	44
AI service	1	22	2200
Sale of feed	13	23	77

Source: Owango et. al., 1998

Table 5: Effects on farm-gate milk price in the Kenyan highlands of selected variables: estimated OLS model for farm-gate milk price formation.

Variable	**Formal milk market price**	**Informal milk market price**
Household transaction characteristics		
Dairy herd size (number of cows)	0.17**	-0.36***
Market infrastructure		
Distance to largest city by tarmac (kms)	-0.07**	-0.14***
Distance to largest city by all weather loose surface roads (kms)	NS	-0.28***
Distance to largest city by dry weather–only roads (kms)	NS	-0.37***
Distance to nearest milk collect center by tarmac (kms)	-0.41***	NS

** significant at 0.05 level, *** significant at 0.01 level. NS= not significant
Source: Adapted from Staal et al, 1999.

Table 6: Effects on probability of dairy cow ownership in the Kenyan highlands of selected variables: estimated probit model for adoption of dairy cattle technology.

Variable	Marginal effects[5] (%)
Household characteristics	
Years education of household head	1.1***
Total land owned (acres)	1.0*
Local area characteristics	
Availability of veterinarian locally	2.2***
Availability of formal market locally	3.4***
Rainfall and temperature[6] (PPE)	2098.6***
Market infrastructure (GIS)	
Distance to nearest urban areas by tarmac (kms)	-1.0***
Distance to nearest urban areas by all-weather loose surface road (kms)	-1.0***

** significant at 0.05 level, *** significant at 0.01 level. NS= not significant
Source: Adapted from Staal et al, 1999.

Table 7: Dairy sales pattern and distance to markets in highland Ethiopia

	Distance to Milk Collection Center	
	0 – 3 Km	3 – 10 Km
Sales/household/day		
Milk (Lt.)	3.2	0.1
Butter (gm)	7.0	97.0
Cheese (gm)	0.0	11.3
Total milk equivalent (Lt.)	***3.2***	***2.4***

Source: Debrah and Anteneh, 1991.

Table 8: Pre-reform sales outlets and price received (Ethiopian Birr/lt) by producers in and around Addis Ababa, Ethiopia

	Peri - Urban		Urban	
	Large	Small	Large	Small
Sales outlets				
Individuals	0.95	1.05	1.63	1.65
Hotels and restaurants	2.00	1.30	1.60	1.35
Other retailers, traders	NA	1.22	1.54	1.21
DDE	1.00	NA	1.00	NA

Source: Staal et. al., 1997

[5] Marginal effect is the % change in the dependent variable (probability of dairy cow ownership) of a 1% change in the explanatory variable.
[6] Rainfall and temperature were represented by a combined index, PPE = annual average precipitation over potential evapo-transpiration.

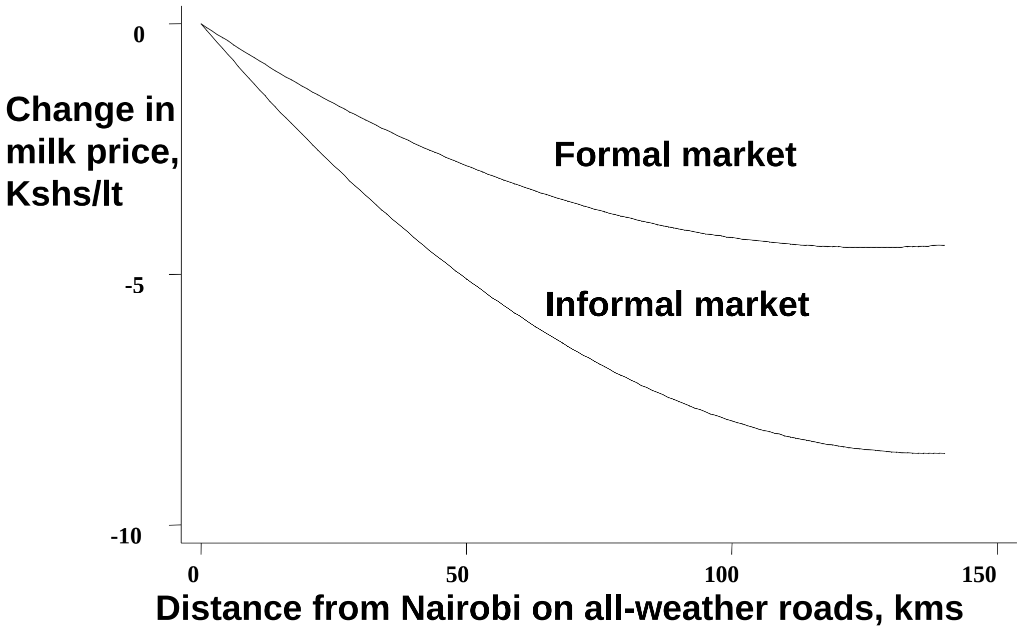

Figure 1: Estimated distance decay functions, for change in farmer milk price with distance from largest city by all-weather road, formal and informal milk markets in the Kenyan highlands (Staal et al, 1999).

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