3.4.7: Cattle Performance

Since the sample of households surveyed had both dairy and local cattle, it was considered more useful to analyse performance by cattle genotype. For the purpose of this study, two genotypes were identified, and these are dairy and local cattle. Dairy animals include all the exotic breeds of cattle while local animals include the borans and zebus.

For dairy animals, mean age at first calving was 32 (sd 6) months while calving interval and lactation length 519 (sd 160) and 520 (sd 214) days respectively. The prolonged calving intervals may not be due primarily to disease or limited access to reproductive services, but due to the fact that many farmers only consider breeding cows after they have been milked for at least 200 days (Odima *et al.*, 1994) a strategy that maintains cash flow but reduces number of calves produced. Local cows' mean age at first calving is 42.8 (sd 7.7) months, 11 months longer than for dairy cattle. Local cattle's mean calving interval is 510 (sd 148) days, which is closer to that of dairy cattle but their mean lactation length, 639 (sd 234) days is longer than that of dairy cattle.

As shown in Table 18 below the mean milk yield for dairy cattle was 5.9 (sd 4.4) litres while the mean milk yield for local cattle was 2.0 (sd 1.9) litres. The decision by farmers to voluntarily lengthen calving intervals and the low milk yields seem to be linked.

Table 18: Production and Reproductive Performance

District	Breed	Calving Interval (days)	Lactation Length (days)	Milk Prod. (litres)	Age at First Calving (mths.)
Maragua	Dairy	471 (168)	-	6.8 (4.7)	32.9 (3.6)
	Local	-	-	-	-
Murang'a	Dairy	539 (164)	471 (169)	4.7 (3.3)	30.7 (4.9)
	Local	566 (208)	-	3.3 (2.5)	-
Kirinyaga	Dairy	598 (189)	518 (178)	4.7 (3.9)	29.5 (5.3)
	Local	-	-	-	-
Nairobi	Dairy	-	-	7.2 (5.6)	29.6 (7.7)
	Local	-	-	-	-
Machakos	Dairy	575 (239)	-	4.9 (3.8)	33.1 (7.7)
	Local	563 (173)	591 (287)	2.1 (2.2)	40 (7.0)
Nyandarua	Dairy	503 (132)	688 (256)	6.5 (4.9)	30.6 (4.0)
	Local	-	-	-	-
Nakuru	Dairy	491 (152)	423 (159)	6.1 (4.3)	34.1 (7.0)
	Local	-	-	3.2 (2.4)	37.3 (9.5)
Narok	Dairy	-	-	-	-
	Local	489 (132)	687 (175)	1.5 (1.0)	47.3 (3.4)
Overall	Dairy	519 (160)	520 (214)	5.9 (4.4)	32.3 (6.0)
	Local	510 (148)	639 (234)	2.0 (1.9)	42.8 (7.7)

NB/ A dash (-) indicates that n was zero or less than 5 observations.

Milk production, consumption and marketing figures reported were in units of bottles and have been standardised to litres (Table 19). Households on average consumed 2 litres of milk daily. The higher amounts consumed in Nyandarua (2.7 litres) and Narok Districts (2.4 litres) reflects higher home consumption due to the low market access and poor infrastructure while the figure for Nairobi was not reported as they tend to sale all the milk being in the Nairobi milk market. Amounts sold, from all milking cows, varied with the highest being 9 litres in Nyandarua and 7 litres for Nairobi and Nakuru respectively. The other Districts sold on average 4 to 6 litres daily. Prices again reflected market access and depended on the market sales outlets. The highest price per litre was paid in Nairobi and Machakos, Ksh. 26.3 and 22.7 respectively. Other Districts were paid around Ksh. 13 with the exception being Maragua getting Ksh. 11. Payment by all market agents is based on volume and not on composition.

Table 19: Quantities of Milk Consumed by Household, Amounts Sold and Price per Litre

District	Amt. Consumed (litres)	Amt. Sold (litres)	Price per litre (KSh)
Maragua	2.3 (0.8)	6.1 (4.4)	11.1 (1.6)
Murang'a	1.7 (0.8)	3.9 (3.4)	13.0 (2.1)
Kirinyaga	2.2(1.0)	4.6 (4.0)	13.0 (1.6)
Nairobi	-	7.0 (3.4)	26.3 (5.0)
Machakos	1.6 (0.7)	4.5 (6.2)	22.7 (7.9)
Nyandarua	2.7 (1.6)	9.0 (6.3)	13.8 (2.4)
Nakuru	2.2 (1.0)	7.0 (8.0)	12.5 (2.2)
Narok	2.4 (1.0)	4.0 (2.4)	13.6 (1.8)

Another result that reflects low productivity is the rapid declining lactation curve estimated from the survey data. Lactation curves for grade, cross and local cattle were estimated from the data using a semi log-linear function presented below:

$$y = \alpha + \beta_1 \ln x_1 + \beta_2 x_2 + \beta_3 D_C + \beta_4 D_g + \beta_5 INT_C + \beta_6 INT_g$$

Where y is milk yield per day, x_1 is months after calving down, x_2 is parity number, D_c is a dummy variable (1 if cross cattle, 0 otherwise) and D_g is also a dummy variable (I if dairy cattle, 0 otherwise). In this model, the comparison category is the "local cattle" and it allows for the comparison of milk production among cattle of different genotypes. The terms INT_c and INT_g represent the interaction variables between genotype and months after lactation and in the above model, are the slope dummies. Three genotype catagories were identified from the data, and these are local cattle, grade cattle and crosses. The lactation curves was calculated using a combination of reported yields for individual animals including; 1) milk at calving, 2) milk at day of survey, and 3) milk at drying-off (with additional reporting of calving

date and drying-off date). A total number of 2256 observations were used to estimate the specified functional form. Figure 11 shows the estimated lactation curves. As expected, grade cattle outperform crosses and local cattle, although milk yields for all cattle are relatively low.

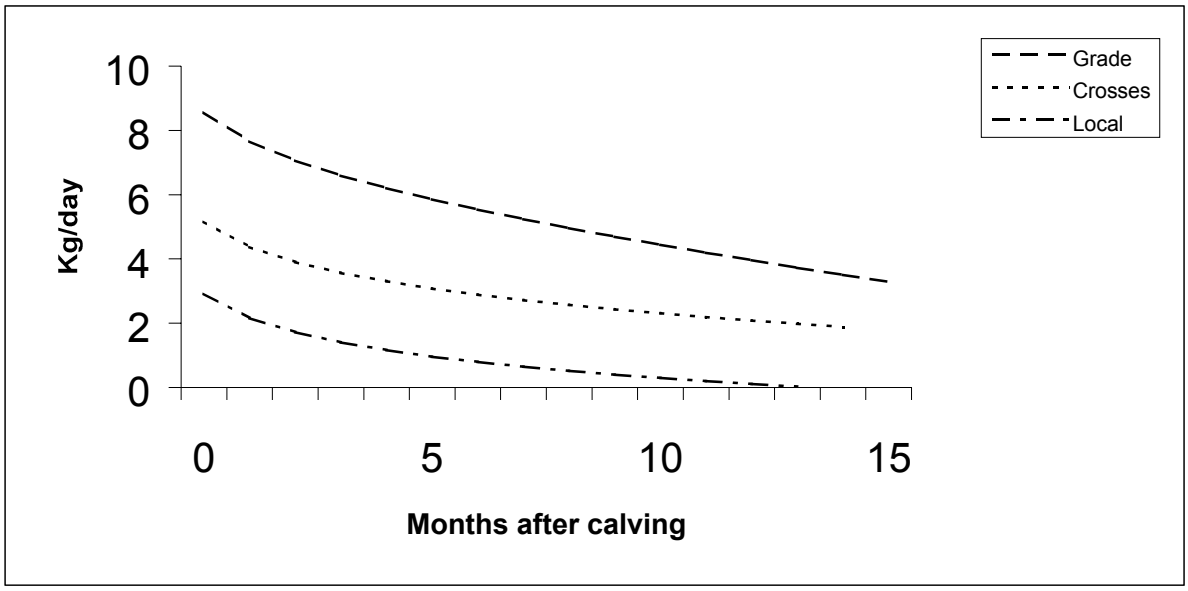

Figure 11: Predicted Lactation Curves for Grade, Local and Cross Cattle

Table 20: Parameter Estimates for Lactation Curves

Yield	Coef.	Std. Err.	t	P>|t|
X_1 (ln_month)	-1.096	.117	-9.358	0.000
X_2 (parity)	.131	.051	2.57	0.010
D_g (grade cattle)	5.75	.250	22.986	0.000
D_c (crosses)	2.254	.460	4.900	0.000
$INTR_g$	-0.50	.022	-6.773	0.000
$INTR_c$	-0.022	.0462	-0.476	0.634
Constant	2.923	.263	11.096	0.000
Adjusted R^2	0.343			

Table 20 summarises the estimation results, and shows the high level of significance in most of the parameter estimates.

3.5 Services and Markets

3.5.1 Input Services

Provision of input services has experienced dramatic changes in the last decade because of policies that support growth of private enterprises (private veterinarians,

para-veterinarians and milk processors) and reduced government support to provision of input services for dairy production. Figure 12 below shows the effective trend in availability (or unavailability thereof) of extension, veterinary and AI services and qualifies whether, if available, they are actually used. The lack of efficient supply of inputs including livestock services is a serious constraint in many areas. Areas in close proximity to Nairobi, dairy co-operatives provide several input services beyond milk marketing, including the bulk supply of animal feed, drugs, AI and veterinary services (Ombui et al., 1995, Owango et al., 1996). Overall 30% of farmers reported availability of AI services from DCS but only half of them use these services preferring also private AI (25%) and GoK AI (10%) where it is still operational.

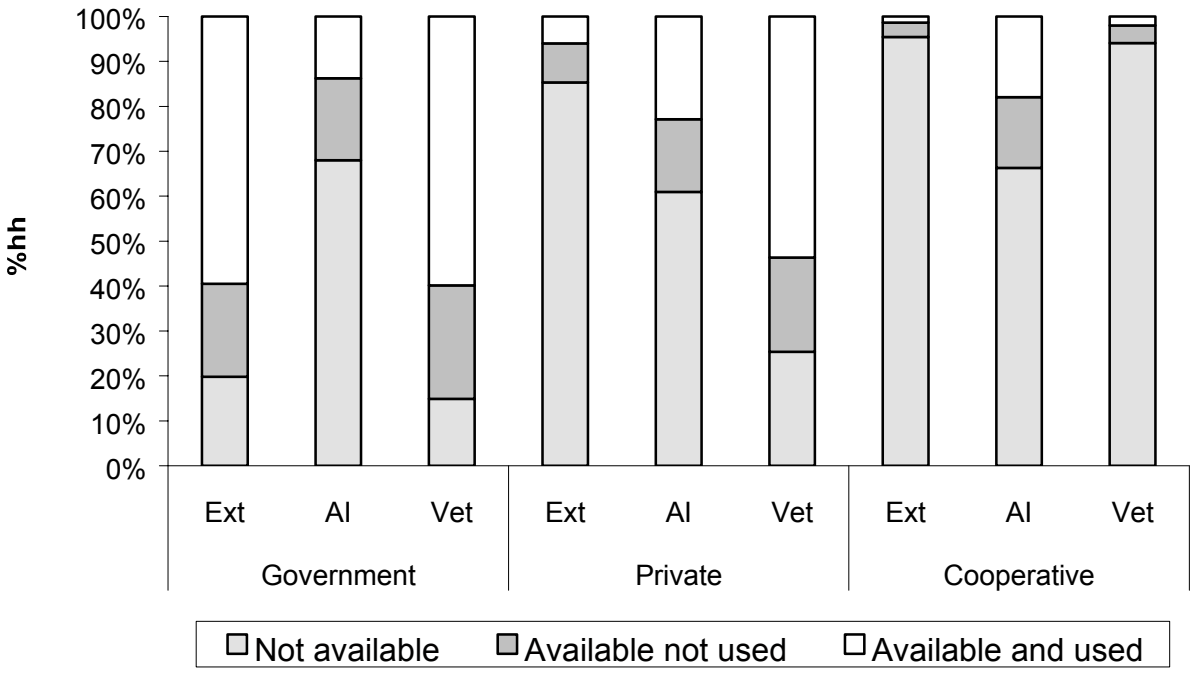

Figure 12: Availability of Input Services By Source: Percent of Dairy Household

Farmers were also asked to indicate the number of extension visits they received in the 12 months preceding the survey. The number of extension services could be taken as an indicator of farmer access to extension. Figure 13 below is a graphical representation of the frequency of extension visits, from all sources (government, private, co-operative etc) in the 12 months period. Apart from Nairobi and Nyandarua districts, all the other districts reported zero extension visits for over 50% of the households surveyed. All Nairobi farmers had at least one extension visit, and they were by far the most well served by extension services. Generally, the result reflects a deficiency in extension services in most of the areas that were surveyed. An important result to note is that despite the liberalisation of extension services, government is still by far the most important source of extension services compared to other sources such as co-operatives, private practitioners and others. Of the extension visits made to farmers, about 84% came from the government, 5%

came from private practitioners while the other sources contributed less that 5% each.

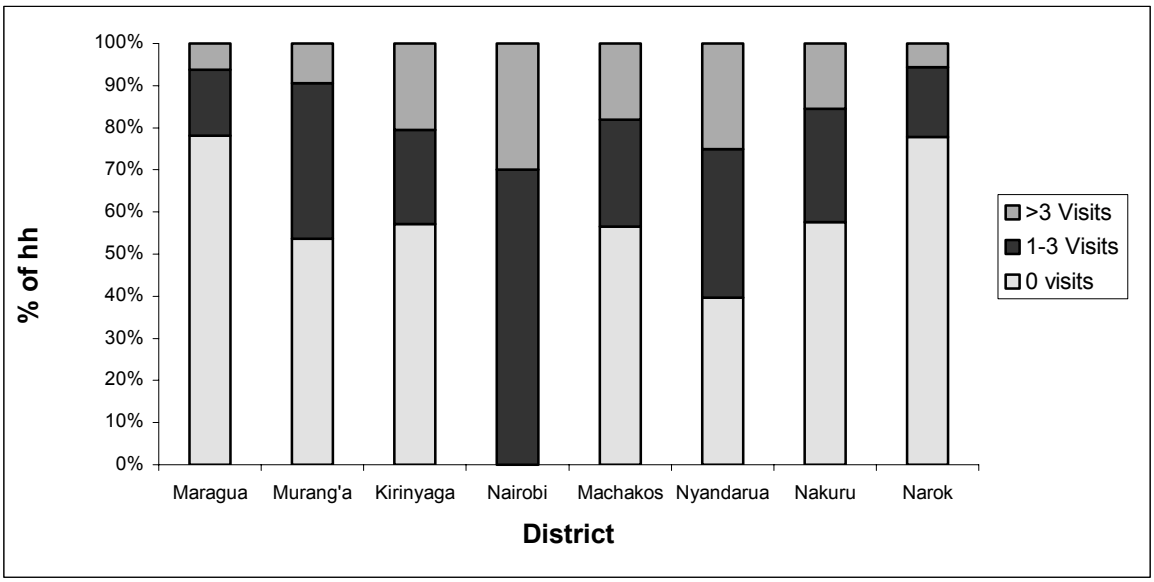

Figure 13: Proportion of households receiving indicated number of extension visits in the last 12 months

3.5.2 Market Access

Nairobi is the major market for farm produce, including perishable commodities such as milk and vegetables, and a source of input services and goods. Table 21 shows how distances to Nairobi varied across the sample, with the furthest farms being in Nakuru District (182 km). Districts in Central Province have relatively better access to the Nairobi market while the ones in the southern Rift have to rely on the emerging market outlets offered by Nakuru. Distances from farm to local market centres, where inputs are generally obtained and where milk collection points are often located, averaged 1 to 6 km. Farmers deliver milk to collection centres in these centres either on-foot or using donkey carts, bicycle, etc.

Table 21: Mean Distances of Farms to Nairobi and to The Nearest Market Centres (Km)

District	Km to Nairobi	Km to Market Centre
Maragua	67.7	1.2
Murang'a	116.2	2.0
Kirinyaga	135.8	1.9
Nairobi	8.3	1.2
Machakos	84.7	2.7
Nyandarua	147.7	3.8
Nakuru	182.5	5.6
Narok	146.1	6.3

3.5.3 Milk Marketing

The marketing of milk has increasingly become decentralised, with greater private sector participation since market liberalisation. Market inaccessibility, caused by poor road infrastructure or long distances, may cause some forced home milk consumption particularly where only morning milk is collected, as was found in parts of Nyandarua, etc. However, it is important to note that even in this milk supply region for Nairobi, the most important market for small farmers is the sale of unprocessed milk to neighbours or in local village markets. There are also numerous informal milk traders and a few formal milk market agents, such as farmer controlled dairy co-operatives and self-help groups, private processors and, to a limited extent, the Kenya Co-operative Creameries (KCC). The overall reported use (% dairy households) of each marketing channel is presented in Figure 14 and show largely sales to individuals (42%), then traders 22%, dairy co-operative societies and groups 12%, hotels and shops 11% and private processors and Kenya Co-operative Creameries each 6%.

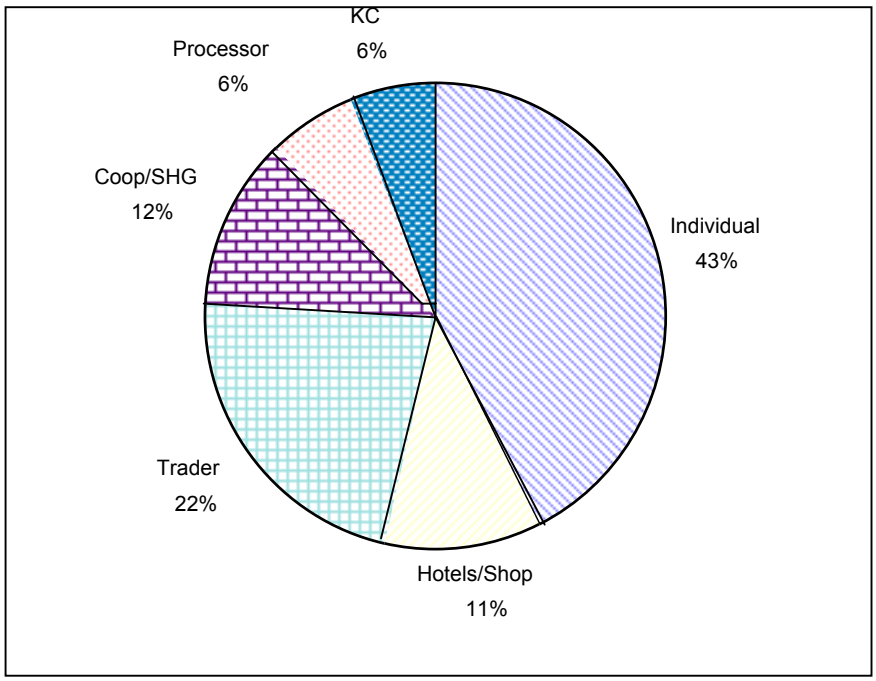

Figure 14: Overall Milk Sales Outlets (% household)

However, the relative importance of the different milk outlets varies widely across the districts surveyed (Figure 15). The areas where farmers sell mainly to an organised channel (coops, private processors and the KCC) include Kiambu (mainly coops), Nyandarua (coops and private processors), and to a lesser extent Murang'a. These tend to be areas where milk surpluses are high, requiring farmers to market milk outside of their locale. In other districts, private traders (hawkers) are important (Nakuru, Murang'a). The reasons for these differences may lie in the local history of institutional development, and remoteness. In milk deficit areas (Machakos, Nairobi and Narok), most milk is sold directly by farmers to neighbours or other consumers. It should be noted that high incidence of direct sales to consumers should not necessarily be interpreted as indicating milk constraints. Rather the opposite is likely to be the case: local sales indicate local milk deficits and strong local demand, so that more organised channels are simply unnecessary.

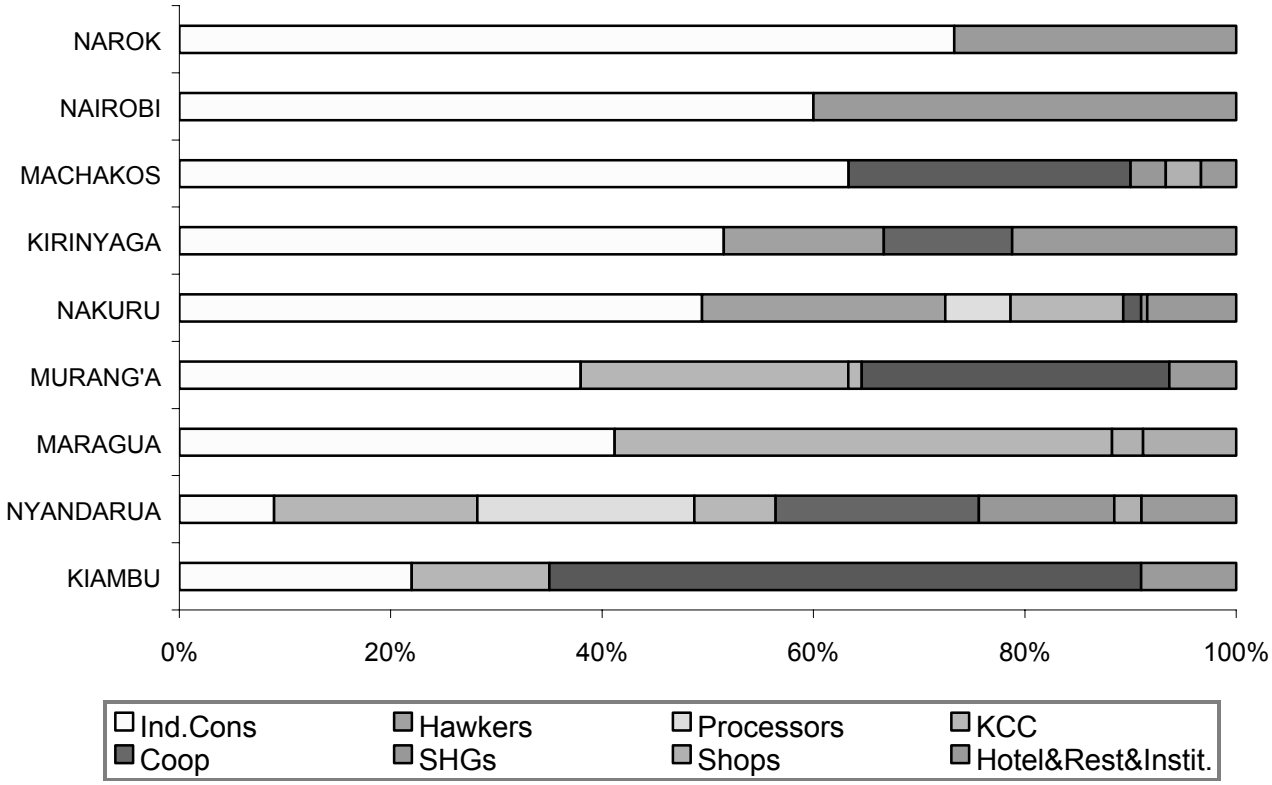

Figure 15: Primary Milk Sales Outlets (% of Farms in Each District)

This interpretation is supported by evidence from milk prices. Milk prices received by farmers varies with the type of outlet used, and are generally highest in the informal outlets such as retail shops, hotels/restaurants, and sales to neighbours (Table 22). Besides type of outlet, another factor that is important in determining producer price of milk is local supply and demand. Farmers living in milk deficit areas like Machakos and Nairobi receive higher prices than those living in milk surplus areas like Nyandarua and Nakuru. Other factors hypothesised to affect producer prices are distance to market, state of the infrastructure and distance to Nairobi among others. Further analysis of this survey data (Staal et al, 1999) has shown conclusively that distance to Nairobi, and quality of roads, have a marked and measurable effect on farm milk prices. They estimate that each additional kilometre of poor feeder road (passable only in the dry season) between a farm and the main road reduced the milk price received by some 35 cents per litre (Ksh 0.35) on the informal market. Poor roads are also likely to affect ability of market agents to operate, reducing their reliability of milk collection. Infrastructure is thus an important determinant not only of returns to smallholder dairy farming, but also of some of the market risks farmers face.

Table 22: Milk Prices Received by Farmers in Central Highlands: l998

Buyer type	Price (KSh/L)	Range
Retail shop	22.50	16.00 - 30.00
Hotel/restaurant/office	17.10	15.10 - 30.00
Individual consumers	16.90	15.10 - 28.30
SHG/Club	15.70	11.00 - 23.50
Private milk trader	14.50	13.80 - 30.00
Private Processor	14.10	16.00 - 25.00
Co-operative	13.60	12.90 - 22.10
KCC	13.20	12.90 - 14.00

Highest prices: Nairobi & Machakos (25 - 30/- per L)
Lowest prices: Nakuru, Muranga, Nyandarua (11-16/- per

3.6 Income

3.6.1 Household Income Categories

Total farm-household cash income (from off-farm sources and farm sales) was reported in six classes. The frequencies for non-agricultural, agricultural and dairy households reporting, within these classes, are shown in Figure 16. These figures do not include household consumption but nevertheless generally indicate levels of household income. The results again show greater representation of dairy households as incomes go up with half of the households in the highest income category (>30,000 Ksh/month) engaged in dairying.

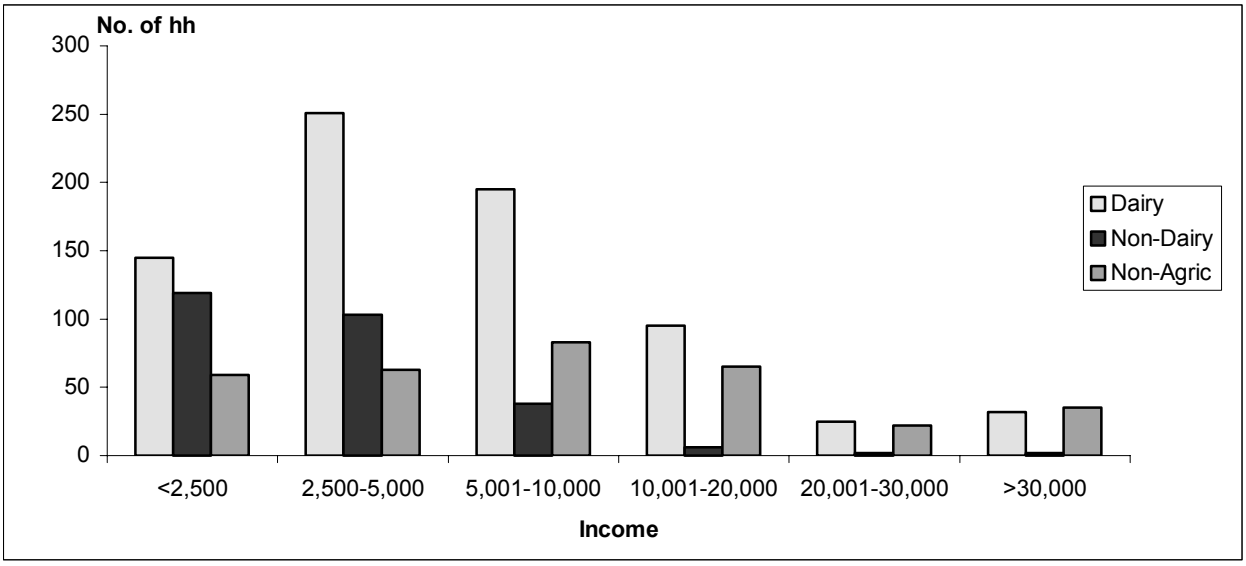

Figure 16: Household Income Categories for Non-agricultural, Agricultural and Dairy Households

The dairy households in most Districts ranked dairy as the main source of farm income. In Maragua 50%, Nairobi 75%, Nyandarua 57% and Nakuru 52% of the households surveyed reported dairy as the main source of farm income. Yet other districts ranked dairy second to sale of cash crops. In Murang'a and Kirinyaga 58 and 76% respectively report sale of coffee as most important while in Narok, 63% ranked sale of wheat as more important than dairy. Machakos has equal ranking, one third each, for dairy, cash and food crops. Overall the findings underline the point that dairy farms generate higher cash incomes and create employment for agricultural households. The net nutrient flows of manure from the dairy animals to cash and food crops has also to be considered, and raises the value of the contribution of dairy production. In a few instances, the value of manure is seen by farmers to be the same as, or greater than, the value of milk especially where milk markets are not reliable.

4. Identifying Target Groups of Dairy Producers for Research and Development Attention

4.1 Background to the Methodology

Developing appropriate interventions to assist smallholder dairy producers, and identifying those which should be targeted requires a clear understanding of the dairy systems. As shown in this study, variation occurs not only in dairy technologies such as feeding strategies, husbandry practices, or breeds of animals, but also in farm/household resource constraints, and the market environment faced by the farm/household. Appropriate interventions should consider all of these factors, and the relationships and patterns among them.

In order to distinguish characteristic patterns of dairy activity existing among the surveyed households, a clustering method was applied to some of the primary variables. The method employs principal component analysis followed by cluster analysis. For a detailed description of the method, see Staal et al (1997) and Gockowski and Baker (1996).

To summarise, the method is motivated by the desire to reduce the number of variables used in the clustering without omitting potentially important information (variation). The principal component method alleviates this constraint by allowing the apparently most important variation from a larger set of variables to be identified and then used to cluster the farm/household observations. Key to application of the method to smallholder dairy producers is the use of a wide range of variables related to dairy production practices, household resources, and market access.

4.2 Selection of Variables Used in Principal Component and Cluster Analysis

The groups of variables used in the principal component analysis were chosen *a priori* on the basis of "themes" considered centrally important not only to the observed heterogeneity among the sample, but also the planned focus of eventual research and interventions.
The themes chosen were:

a. Level of intensification of the farm dairy system,
b. Farm/household resources available, and

c. Level of access to output markets and input services.

As seen from the description of the survey results, there is considerable variation in the level of intensification of dairy activity between farm/households, where intensification is related to the level of purchased inputs per animal and the output of milk per acre of land used. Farm/household resources such as labour and capital may be critical to intensive dairy farming, where dairy requires labour for cut-and-carry feeding and capital for purchases of animals, cattle housing, feed or other inputs.

Market access is also important in this market-oriented system, which the survey showed to produce a large proportion of the milk marketed in Kenya, and where nearly 80% of extracted milk is marketed.

For each theme a set of variables, considered to reflect the primary measures of variability within that theme, was chosen. Table 23 below shows the variables used to indicate the level of intensification of dairy production system, including relative use of maize, napier grass, concentrates, the stocking rate, grazing system and density of milk production.

Table 23: Variables used to Indicate Level of Dairy Intensification

Name	Description	Mean (n=354)	Std dev
MAIZ_CAT	Acreage of maize planted per TLU of dairy cattle	0.59	0.82
NAP_CAT	Acreage of napier planted per TLU of dairy cattle.	0.19	0.42
CONC_CAT	Concentrate feed purchased, in Ksh, per TLU of dairy cattle	1,487	3,257
FODD_CAT	Fodder purchased, in Ksh, per TLU of dairy cattle	491	1,159
LAND_LIV	Total household land in acres per TLU of livestock	2.80	2.90
MILK-ACR	Milk produced per acre	2.16	2.72
COWFEED	Grazing system	2.55	1.15

Similarly, a set of variables was chosen to address the theme of household resources available to the dairy activity and to the farm/household in general. The variables selected as important measures of household resources were female-headedness, off-farm employment by household members, the overall household income level, the total land held by the household and the ratio of dependants (children under 15 and adults over 65 years) to adults in the household. These variables are described in Table 24.

Table 24: Variables used to Indicate Level of Household Resources

Name	Description	Mean (n=354)	Std dev
FEMHEAD	Whether household is female-headed, 1=yes, 0=no	0.22	0.42
OFF_ADT	Proportion of adult (>16yr) hh members who work primarily off-farm.	0.10	0.17
INCOME	Level of total household cash income from all sources, where 1 <2,500 Ksh, 2 is 2,500-5,000, 3 is 5,001-10,000, 4 is 10,001-20,000, 5 is 20,001-30,000, 6 >30,000.	2.77	1.26
TOTLAND	Total acres of land held by household	8.50	13.10
DEPEN_RT	Ratio of dependants to adults	0.41	0.26

Female-headed households were postulated to have poorer access to resources such as formal credit facilities, co-operative services, etc. Off-farm employment of household members affects labour availability for dairying, but may also affect household wealth. Monthly cash income level and total land held were considered indicators of wealth. Dependant ratio may affect household milk consumption, capital liquidity, and availability of household labour.

Finally, a group of variables were selected to measure access of farms to markets. These included distance of the farm to Nairobi, the availability of veterinary services locally (offered mainly by the government and private sector), availability of GoK extension services locally, the farm-gate price of milk received by the farmers, co-operative membership, and milk sales to informal market outlets. The variables are described in Table 25 below. The study shows that government veterinary and extension services were still significant to over half the farmers. Unlike in Kiambu, lack of use of non-governmental outlets is an indicator of lack of market development as a result of low market access, while co-operative membership is not an indicator of access to both input and output markets as most of the cooperatives do not offer any veterinary or extension services. Complete data for the three sets of variables was available from 354 dairy farm/households.

Table 25: Variables Selected as Indicators of Market Access in the Principal Component Analysis and Their Means and Standard Deviations

Name	Description	Mean (n=354)	Std dev
DISTNBI	Distance to Nairobi, in Km	144.89	54.64
VETAVAIL	Availability of veterinary services (1=yes, 0=no)	0.08	0.09
EXTAVAIL	Availability of extension services (1=yes, 0=no)	0.003	0.05
DDFRPRC1	Average price received per litre of milk in most recent dry season Ksh.	13.51	3.31
COOPMEMB	Co-operative membership: 1=yes, 0=no.	0.47	0.50
INFRMKT	Reported milk sales to non-co-operative outlet in last 12 months, 1=yes, 0=no	0.91	0.28

4.3 Cluster Analysis

Cluster analysis was then carried out using the new variables derived through principal component analysis from the variables shown above (see Staal et al, 1998 for a description of the method). The number of clusters was set to different values and the results compared and interpreted for ability to differentiate the observations along the desired axes. Clustering into eight clusters was selected. From these, 4 clusters contain most of the farm/household observations with cluster 1 containing the largest group. Table 26 shows the frequency of households falling under each cluster, and the mean cluster values of a number of descriptive variables from the original survey variable set.

Table 26: Means of Farm/Production, Household and Market/Institutional Participation Characteristics for the Identified Major Dairy Farmer Groups

Cluster	Informal Resource Poor (1)	Intensive Part-time (2)	Extensive Landed (3)	Specialist (4)
Number of households	179	68	67	26
Percent of households*	51	19	19	7
Farm/Production Characteristics				
Farm size (acres)	4.0	4.7	23.3	6.1
Napier acreage	0.2	0.4	0.4	0.6
Maize acreage	0.8	1.0	1.9	1.0
Dairy cattle TLU	1.8	2.3	5.0	2.0
Farm acres per TLU	2.0	1.6	5.0	3.0
Napier acres per TLU	0.1	0.2	0.1	0.4
Concentrate purchased Ksh/TLU/yr	1,300	2,600	1,800	18,700
Fodder purchased Ksh/TLU/yr	390	590	930	6,740
Milk prod./day of calving interval (lts/day)	3.9	3.9	7.0	4.2
Household Characteristics				
Age of household head	50.3	51.3	52.2	48.4
Years dairy experience	17.0	21.2	21.3	21.3
Female hh heads (%)	23	24	20	15
Total household size	6.2	4.5	7.4	5.7
HH adults working off-farm (% of adults)	4	29	5	10
Hh income category	2.1	3.2	3.6	3.4
Market /Institutional Participation Characteristics				
Distance to Nairobi (km)	164	111	134	142
Distance to market (km)	4.6	4.2	6.1	2.5
Co-op membership (%)	34	67	66	69
Availability of vet services (%)	90	100	85	92
Availability of extension (%)	70	80	77	68
Informal milk market participation (%)	99	92	75	78
Multiple market outlets (%)	84	86	63	91
Avg price for milk (Ksh/lt)	12.5	13.8	14.9	14.6
Avg qty of milk sold (lt/day)	2.6	4.3	7.0	5.2

* Some 4% of farms did not fall into these clusters.

Farmers in the largest cluster (1) have the smallest land holdings (4 acres on average), buy very little fodder (less than Ksh 400 per year), have the lowest levels

of total income, and operate mostly through the informal market. They plant only a small amount of land in Napier. Only 34% of them are members of dairy cooperatives, compared with much higher proportions among other farmers. They receive the lowest price for their milk of the 4 groups, which may be related to the fact that they tend to the furthest from Nairobi. Nearly a quarter are female-headed households. Given these characteristics, we will consider these to be the **Informal Resource Poor** (IRP) group of dairy farmers. These farmers comprise some 51% of the dairy farms surveyed, and are thus by far the largest group.

The second largest cluster (2) is composed of farmers with only slightly larger land holdings (4.7 acres), but who grow more Napier and who purchase significantly more concentrate feed and fodder. Milk yields however are as low as those in the IPR group. They tend to be found relatively close to Nairobi, and 66% of them are members of dairy cooperatives. A significant proportion of adults in these households (29%) work off-farm, and 24% of the households are female-headed. These are thus **Intensive Part-time (or Peri-urban) Dairy** farmers (IPD), and make up 19% of the dairy farms surveyed.

Farmers in another cluster of about the same size (3) have large land resources (23 acres) and plant more Napier (0.4 acres), although they also purchase fodder and concentrates. Possibly as a result of these land resources, they exhibit the highest milk yields, at 7 l/day of lactation. They have higher income levels than the other farmers, and tend to rely on dairy cooperatives to market their milk. They can be called the **Extensive Landed Dairy** farmers (ELD).

The last significant group is distinguished primarily by the very large amounts of concentrate feed and fodder they purchase, as well as larger areas of Napier planted (0.4 acres per TLU). More than 90 % of them also rely on multiple market outlets to sell their milk. These are characteristics of specialization in dairy production, and so this group can therefore be called **Specialised Dairy** (SD) producers. The milk yields they obtain remain relatively low, however, at 4.2 liters per day. They comprise a small group within the dairy farmers at less than 10% of the total.