Socio-economic characterisation of smallholder dairy systems in The Gambia: Milk production, marketing and consumption

Socio-economic research Working Paper 1

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Executive summary

The Gambian government, with the assistance of donors, is involved in the promotion of the local milk and dairy products sub-sector. The farming system in this country is characterised by the predominance of mixed crop-livestock production. The cattle stock is mainly composed of N'Dama, a breed described as a low milk producer. With a large number of cattle, a substantial increase in the domestic milk supply seems feasible, and a thorough approach of research-development is provided. In order to provide insight on the current production, marketing and consumption of domestic milk and milk products in The Gambia, a micro-economic-based approach is used.

Furthermore, instead of the traditional system-based approach (intensive, semi-intensive and extensive) used in milk production studies in Africa, few studies have addressed the issue from a farmer-based approach. Similar criticism can be formulated for dairy marketing studies that distinguished between formal and informal marketing systems of dairy products in Africa. Therefore, the system-based or "meso-economic" approach is limited in identifying what constraint resource-based farmers face in milk production; system constraints are identified and then attributed to the farmers operating in the system. The difference between these approaches is that the former considers the system in which milk production takes the place as determinant of the performance of the domestic dairy sub-sector. We argue here that even the system-based approach can provide some useful information on milk production, however, it does not facilitate tackling the constraints nor identifying potential at the root. In other words, because individual farmers own production factors, they are the very persons who decide for or against an orientation towards milk production in the livestock-based agricultural system. The decision to produce is taken in relation to the resources at the farmer's disposal. Ultimately, the farmer decides what technology to use in the production process.

As increased milk production is viewed as a means to alleviate poverty, particularly for smallholders, it is important to develop other approaches in order to effectively capture the limiting factors of the domestic milk sub-sector. This study attempts to analyse constraints and potentials to local milk production, marketing and

consumption; and to identify paths for its development. The overall objective is to evaluate the cost-effectiveness and the sustainability of the local milk sub-sector. The specific objectives are: (1) to characterise livestock production with focus on milk-oriented producers; (2) to typify milk production-marketing-consumption patterns; and (3) to evaluate the economic viability of the current system.

Primary data were gathered through surveys at the farm, market and household consumers level. These surveys covered the period from 2001 to 2002. At the production level, a baseline survey of 501 farmers was carried out in 2001, in order to collect information on farm household resource endowment, their production objectives and their needs for improved technology in the mixed crop-livestock system. Following this, a sample of 90 farm households with milk production as their objective was selected for in-depth survey on each component of milk production (resources, herd structure, feeding, health care, genetic improvement, milk production and management, etc.). At the marketing level, surveys were conducted in 2001 and 2002 in order to identify the structure of dairy product markets, the conduct of the economic agents involved and the performance achieved. Some 70 local milk sellers and 35 shops of various sizes were enumerated. Finally, surveys on the consumption of dairy products were realised in 2001 and 2002 at both individual and household level. Two hundred individuals were enumerated on their preferences of dairy products and the amount purchased as well as their socio-economic background. In order to evaluate the consumption patterns at the household level, 35 heads of households were enumerated using the same variables.

Data were analysed using the SPSS package. Descriptive statistics allowed assessing the variability among milk producers, sellers and consumers. Cluster and discriminant analyses were applied to the producers' data to investigate the similarities (dissimilarities) of milk producers in terms of their resource endowment and the factors contributing to the smallholders' discrimination. Partial budgeting methods were applied to evaluate the economic viability of the current milk production and marketing systems. A simple log-linear demand function for dairy products was estimated to provide insight on the effect of change in the household income and dairy products price on the demand of these products.

The results indicate that milk production is strongly integrated in the mixed crop-livestock farming systems. Resources in these systems are unequally distributed amongst smallholders. Two resource-based groups of smallholders are identified: high resource and low resource farmers. Each group has shown different capacity to uptake improved agricultural technology. As a consequence, the agricultural income in general also differs. Although the levels of cost-effectiveness differ between the high and the low resource group, all smallholder dairy farms are on average cost-effective. This translates to an overall net cash income per cow of 521 Dalasis/household/year, and net cash per variable cost of about 4 Dalasis/household/year. The potential of the smallholder dairy farms in generating income is therefore established.

The results of the marketing patterns also show the existence of potentials. Although non-organised, domestic milk products are marketed through three outlets: farmers to consumers, farmers to consumer through sellers, and farmers to consumers through collectors through sellers. Analysis of the last two outlets reveals that both result in positive commercial gross margin for sellers, varying between 2 and 3 Dalasis/litre. However, the latter outlet (farmer-collector-seller-consumer) appears to be more efficient in terms of increasing the market supply of milk and milk products, employment creation and income distribution.

Finally, analysis of consumption patterns is also consistent with the existence of potentials for domestic milk and milk products. It is shown that these products still take advantage of the traditional habit and preferences. Sour milk constitutes the most preferred product (33% of the sample) as compared to imported products (11% for skimmed milk, the most preferred amongst this group). In addition, the estimated income-elasticity indicates that the demand for imported products is significantly influenced by the income (1.13) whilst that of domestic is not (0.57).

Several conclusions can be derived from this study, at all three stages: production, marketing and consumption. The most important seems to be the approach. At the production level, the use of a producer-based approach provides the appropriate information. As compared to the previously used (system-based) approach, the (producer-based) micro-economic approach has an advantage of placing farmers' resources as a key element for milk development, while the former considers the

system in which farmers are operating. The implication of the producer based approach is that technology transfer should be targeted at the smallholders level if it is to impact on agricultural production in general and dairy production in particular. Due to differences in resources endowment, needs for technology differ and thus the capacity to uptake them.

Secondly, despite the limited resources and technology, milk production is shown to be economically viable. On average, smallholders are cost-effectively operating in milk production. Milk sellers are performing well and consumers are demanding more milk and milk products. There is however, no formal structure for domestic milk marketing and this makes it difficult for any technical and policy intervention at this stage. Several constraints, such as inadequate equipment, lack of transportation and financial support, are hampering the marketing of milk products. These have been identified as entry-points to improve the quality of milk products supplied to consumers as well as increase the quantity and subsequently the performance of the system.

Thirdly, the results show that demand for both imported and local dairy products exists. Although preferences are for local milk products, in general consumers combine several dairy products to satisfy their nutritional needs and tastes. Due to the traditional consumption pattern of local milk, the demand for this type of product is inelastic to change in prices. Likewise, demand for local dairy products is inelastic to change in income. Put together, all these facts indicate that domestic dairy production is facing potential demand that is far from being satisfied. The existence of unmet demand is proven by the increasing imports of dairy products.

I. Introduction

In several parts of West Africa, trypanotolerant cattle are milked to provide for human consumption, but it is generally acknowledged that this breed has a low milk-production potential (Ferguson, 1988; Agyemang et al., 1997). Starkey (1984) described the N'Dama as a beef breed with very low milk production. However, despite limited milk productivity, N'Dama cattle - the most common trypanotolerant breed in the tsetse infested zone of West Africa - are an asset in small-scale dairy production as an important source of cash income for farm-households. Moreover, growth in demand for dairy products in sub-Saharan Africa is projected to increase over the next 20 years, due to expected population and income growth (Holloway et al., 2000). According to Delgado et al. (1999), milk production and consumption of dairy products are expected to grow in the region by 4% annually between 1993 and 2020.

Recognising the opportunity for increasing smallholders' welfare through milk production, international donors (e.g., African Development Bank) are showing interest to invest in the dairy sub-sector in West Africa. Efforts have been directed into cross breeding and artificial insemination schemes. The promotion of artificial insemination provides new opportunities to increase domestic milk production, and to reduce the strain on foreign currency reserves caused by large imports of dairy products. Senegal, Guinea and The Gambia have opted for such innovative technology. Although upgrading indigenous cattle productivity through artificial insemination could result in increased milk production, there are concerns that the benefits of this expected growth may bypass resource-poor livestock producers in the region.

In fact, compared to the extensive livestock production systems, intensification based on introduction of exotic breeds and management of highly productive crossbred cattle entails additional costs, particularly in the absence of enabling policies to sustain the development of the dairy industry. Small-scale milk producers face many hidden barriers making it difficult to benefit from market opportunities. Amongst these are access to markets and productive assets (Staal et al., 1997), high marketing costs for

liquid milk, thinness of markets for liquid milk and the risk associated with marketing of perishables (Holloway et al., 2000) that may negatively influence the outcomes of artificial insemination programmes. Under such conditions, changes in sector and macro-economic policies although necessary, are not currently sufficient to provide the required incentives for smallholders.

In The Gambia, little attention has been paid to the dairy products market and the performance of the consumption-to-production chain. The paucity of information available on smallholder dairy production has led to inconsistent policy interventions in the dairy sub-sector. Hence, it is urgent to know what interventions, either in the private or public sector, are suitable to better support the development of dairy production. Moreover, there is a need to evaluate the management skills of producers and assess the prerequisites of a favourable economic environment.

The report reviews and characterises milk production, consumption and marketing potentials and constraints. It considers milk production as part of the livestock-based agricultural system and evaluates the viability of this sub-system with regard to smallholder resources.

II. Objectives and research approach

2.1. Objectives

The overall objective of this study is to evaluate cost-effectiveness and sustainability of milk production with regard to the current socio-economic environment. Specific objectives are:

1. Characterise the livestock production system with a focus on milk production;
2. Typify milk production-marketing-consumption patterns;
3. Economically evaluate the sustainability of technological interventions aiming at improving milk production.

2.2. Research framework and Data collection

The conceptual framework takes a production-to-consumption approach, as described in Rey et al. (1993) and Staal and Shapiro (1996). However, instead of the traditional system-based characterisation, we use a micro-economic producer-based approach that is based on the producers' resources endowment. In fact, production systems have developed in response to the market demand and have emerged depending on available resources (Tegegne et al. 2002). In this system approach, production, processing, marketing and consumption were considered sub-systems of a dairy system. In the situation of The Gambia, we studied the dairy system as a part of the overall farming system. Although an artificial insemination programme was launched in 1994 to promote the development of dairy systems in The Gambia, its impact remains to be seen outside the research stations as only few crossbreds have been disseminated to the farm level.

This study was built around the notion of increasing the productivity of mixed crop-livestock systems where milk is an important output. Surveys were conducted in three divisions of The Gambia (Central River Division, Lower River Division and Western Division). A baseline survey was first conducted to gather information on farming activities, constraints and opportunities. The baseline survey helped to constitute a sample frame of farmers involved in livestock and milk-oriented production. A total of 501 farmers were enumerated and data collected on production activities (livestock, crop and off-farm activities), production objectives, utilisation of crop and livestock products and cash farm income, etc. This survey was conducted between April and May 2001.

Following this, 90 farmers were randomly selected based on milk production activity as a selection criterion. The distribution of farmers between the three Divisions was: 28 farmers in the Central River Division, 20 in the Lower River Division and 42 in Western Division. A second survey was then conducted and the following data collected namely, the stock and structure of the farm herds, breed composition, farm assets and investments, milk production management, milk consumption and selling, feeding and disease management, etc.

On the marketing side, a survey was conducted on the main markets in Western Division and Kanifing Municipality: Serrekunda, Brikama and Bakau, Latrikunda. These markets were selected based on the information gathered during the baseline survey. A questionnaire based on the market structure-conduct-performance paradigm was administered. This consisted of identifying the marketing structure, analysing the strategies implemented by all agents involved in marketing and estimating the economic outcome. Information related to the milk dealers, the origin and type of milk sold, the marketing costs and revenues, milk price trend, etc. were collected from 71 dealers from July to September 2001, and December 2002.

The third group of surveys dealt with milk consumption patterns. An open-ended questionnaire was used to collect information on the characteristics of milk consumers, their preferences for different types of milk, etc. Based on the demand driven approach, this survey was conducted in the peri-urban area in the Western Division and directed at 200 individual consumers between June and August 2001. Another survey was directed at 45 households in the same area during December 2002.

2.3. Data analysis methods

2.3.1. Analysis of dairy production systems

Frequency and descriptive statistics were used in preliminary analysis to characterise farm households involved in milk production. Further analysis to typify smallholder dairying farms households was conducted. Stepwise Cluster Analysis was used to predict group membership from a set of structural variables including household labour, the size of the farm, the number of each cattle breed owned by the household, the investments in agriculture equipment, etc.

Smallholder farm households were discriminated according to their resources endowment using Discriminant Analysis. Then, constraints and potentials for each group of resource-based farm households were analysed. Each type of farmers was assessed from an economic standpoint to determine the present financial and economic gross margin of smallholder milk producers. Economic viability of smallholder dairy enterprise is an important aspect to examine in order to justify the farmer's decision to

engage and invest in this enterprise. The gross margin estimate was the criterion retained in evaluating smallholder dairy systems' viability. In addition, to evaluate milk production from an economic efficiency aspect, viability assessment was based on the gross margin per cow or gross margin per unit cost to represent the returns to each Dalasi invested (@US$ 1 = 15.30 Dalasi in 2001). It should be noted that in this report smallholder dairy enterprise, farm household and smallholder milk producer are interchangeably used and are referred to as the same object.

2.3.2. Analysis of dairy marketing systems

Following the structure-conduct-performance model developed by Bain (1968), milk marketing in the Kombos (Western Division) and Kanifing Municipality was analysed. The structure of milk markets was identified, including types of dealers, equipment, transport and storage facilities. Marketing costs were estimated for each identified channel. Then, the gross commercial margins (GCM) were evaluated for each channel.

2.3.3. Analysis of local dairy products consumption

The structure of the demand for locally produced dairy products was examined. The socio-economic characteristics of consumers were identified and their preferences for dairy products were assessed. A demand function for dairy products was estimated using a log-linear function.

RESULTS

III. Agricultural production systems

3.1. Description of mixed crop-livestock production systems

The results show that productive resources are not equally distributed among farmers in the mixed crop-livestock production systems of The Gambia (Table 1). Seventeen percent of surveyed farmers do not own cultivated land and 48.6% are not keeping any animals. The skewness of the distribution, as measured by the standard

deviation (SD), indicates that the highest inequality is found with cattle, whilst the lowest is with sheep ownership.

Table 1: Structure of animal husbandry and crop production of farm households (N=501)

Statistics Variables	Minimum	Maximum	Mean	SD
Household size	1	150*	12	10
Cultivated land (ha)	0	70	5.46	5.09
Cattle (heads)	0	108	2.96	12.88
Sheep (heads)	0	16	0.40	1.49
Goats (heads)	0	30	1.83	3.32
Poultry (heads)	0	100	2.51	7.93
Pigs (heads)	0	17	0.10	0.99

* Is an exceptional case of a Marabou's household with its Koranic students who live, produce and eat in this household. Source: Baseline survey (April-May 2001)

3.2. Production objectives and product utilisation

The production objectives of the mixed crop-livestock farmers are multiple (Table 2). Irrespective of livestock species, most farmers raise animals to produce meat. Thus meat production is ranked as first by 97.3% of cattle owners, followed by draft power and milk production with 19.2% and 16.4%, respectively. As cattle are multiple purpose animals, farmers attach different objectives to rearing of cattle.

Table 2: Livestock production objectives (% of households with animals)

Production objectives	Cattle	Sheep	Goats	Poultry, pig
Meat	65.8	100	100	100
Milk	2.7	0	0	0
Meat and milk	12.3	0	0	0
Meat and draft	17.8	0	0	0
Meat, milk and draft	1.4	0	0	0
Valid observations	121	97	225	90

Source: Baseline survey (April-May 2001)

Households with cattle pointed to meat production as the most important single production objective. About 66% of the households with cattle aim at producing meat. The remaining 33% smallholder farmers are involved in cattle rearing with multiple objectives. Meat and draft objectives appear most important to cattle owners (18%). Farmers who indicated three production objectives (meat, milk and draft) represent only 1.4%.

On the crop production side, food is the only production objective. To achieve this objective, smallholders adopt crop diversification as a production strategy; whereby, several crops are produced by one household either in association or as single crops in the same plot. The results in Table 3 show that most farmers produce crops for household consumption. However, fruit and vegetable are produced mostly for cash generation. As a characteristic of diversified farming systems, crop products are used to satisfy the multiple demands of the households, including home consumption and cash generation.

Table 3: Utilisation of food and non-food crops in the study zone (% of households)

Products utilisation	Rice	Groundnut	Millet	Maize	Fruit	Vegetable	Other[a]
Self consumption	98.99	20.76	99.36	88.57	3.22	4.60	41.67
Cash generation	1.00	32.63	0	8.57	86.02	87.36	43.75
Both	0	46.61	0.64	2.86	10.75	8.04	14.58
Valid observations	399	236	311	35	93	87	48

[a] including cassava and beans.

Source: Baseline survey (April-May 2001)

Likewise, the livestock products fulfil several utility functions of the smallholder farmers. These utilities seem to be related to the livestock species. For example, for cattle and pigs, farm households reported no home-consumption. However, when slaughtered, a part of cattle or pig meat can be taken for household consumption. On the other hand, sheep, goats and poultry are specifically used for household consumption.

Table 4: Livestock products utilisation in the study zone (% of households with animals)

Products utilisation	Cattle	Sheep	Goats	Poultry	Pig
Self consumption	0	12.24	11.30	37.80	0
Cash generation	68.49	51.02	42.94	21.95	62.50
Cash and consumption	12.33	36.74	45.76	40.24	37.50
Cash and cultivation	19.18	0	0	0	0
Valid observations	121	97	225	82	8

Source: Baseline survey (April-May 2001)

These results point out the importance of livestock products (table 4) as cash generating sources for most of animals owners, compared to crop products (tables 3).

3.3. Farming systems, products and production objectives

The farming system in The Gambia is characterised by diversity in crop and livestock production. Crop production systems comprise cereals, leguminous crops, vegetables and fruit trees. Farm households often combine multiple productions. The most important crop is rice, grown by 80.4% of the sample. Crop diversification within farm households is predominantly represented by the combination of rice, millet and groundnut (24% of crop farmers). Rice and millet combination is practiced by 17% of the farmers. Forty-nine percent (49%) of the sample grow groundnut. In addition, groundnut is rarely produced as a single crop in farm households (1.6%).

Likewise, livestock production is characterised by the diversification of species. Most of the households with livestock are engaged in goats husbandry (29.8%). Poultry, cattle and sheep are kept by 16.6%, 15.2% and 9.2% of the surveyed households, respectively. The combination of cattle and goats is the most frequent on farms, with 6.4% of sample households. Table 5 summarises the distribution of the households regarding crop and livestock production.

Table 5: Crop and livestock integration practices amongst farmers in The Gambia

Percentiles	Crop	Livestock
25	Rice	None
50	Rice, groundnut and millet	Cattle
75	Rice and maize	Cattle and goats
Modal production	Rice, groundnut and millet	None

Source: Baseline survey (April-May 2001)

For crop production, over 25% of farmers produce rice and 75% combine rice and maize. Pull altogether, the modal production is to combine rice, groundnut and millet. On the other hand, over 25% of households belong to a sub-sample without livestock. In the sub-sample with livestock at least 50% own one cattle.

As shown above, livestock and crop farming are diversely practiced among the so-called smallholder farmers in The Gambia. It is therefore worthwhile to take into account this diversity of farm households in the analysis in order to draw consistent conclusions on farmers' strategies and the economics of farms activities. This attempt is made in the rest of this document.

3.4. Discriminant analysis of smallholder farm households

Results from the discriminant function analysis indicate that 99.6% of the original grouped cases using K-Means Cluster analysis were classified. Two cases of group 1 failed to belong to this group and were shifted to group 2. Smallholder farms can then be discriminated into two unequal groups according to their endowment of land, labour, cattle, sheep, goats, pigs and poultry. Group membership classification indicated that 3.19% of the cases belong to group 1 with relative high resource (HR) and 96.81 % to group 2 with low resource (LR) endowment.

Test of significance of the discriminant function provided an Eigenvalue of 3.266 with 0.875 for canonical correlation. Since the Eigenvalue was greater than 1 and the canonical correlation greater than 0.6, we conclude that the two group discriminant function has then well discriminated between the two groups. A

cumulative percentage of 100% was also found, indicating good fitness of the discriminant function.

Results of tests of equality of group means are summarised in Table 6. Except for the means of poultry owned by each group, the results indicate high significant differences (at 1% level) of means between groups for household size, land cultivated, cattle, pigs and number of owned sheep. Each group differently owns goats at 5% level of significance.

Table 6: Results of tests of equality of group means

Variable	Wilks' lambda	F	Df1	Df2	Significance
Household size	0.866	77.06	1	499	0.000
Land cultivated	0.923	41.59	1	499	0.000
Cattle	0.273	1326.07	1	499	0.000
Goats	0.992	4.139	1	499	0.042
Sheep	0.910	49.21	1	499	0.000
Poultry	1.000	0.025	1	499	0.875
Pigs	0.973	13.79	1	499	0.000

Source: Survey data

The overall test of the discriminant function yielded Wilks' Lambda of 0.234 (Chi-square = 720.235 with df = 5). Table 7 shows the standardised canonical discriminant function coefficients. Cattle number has largely positively contributed to discriminate farm households into the two resource-based groups. Likewise, household size, pigs and cultivated land positively contributed at different levels of significance to discriminate farmers. The probability that a farmer belongs to group 1 increases with the resources. On the other hand, the number of goats was a negative discriminant variable. That is, the probability that a farmer belongs to group 1 decreases as the number of goats owned increases.

Table 7: Standardized canonical discriminant function coefficients

Variables	Cattle	Cultivated land	Goats	Pigs	Household size
Coefficients	1.002	0.144	-0.127	0.223	0.271

Source: Survey data

The case summaries of descriptive statistics, that characterise both resource-based groups, are presented in table 8.

Table 8: Summary of the resources distribution among smallholders

Group	Statistics	Cattle	Cult. Land	Goats	Sheep	Hh. size	Pigs	Poultry
HR	N	18	18	18	18	18	18	18
	Mean	59.78	12.78	3.39	2.72	27.39	0.94	2.22
	SE	7.50	3.77	1.26	1.09	4.96	0.94	2.22
LR	N	483	483	483	483	483	483	483
	Mean	0.85	5.19	1.77	0.31	11.22	0.07	2.52
	SE	0.15	0.18	0.15	0.05	0.31	0.03	0.36
Total	N	501	501	501	501	501	501	501
	Mean	2.96	5.46	1.83	0.40	11.80	0.10	2.51
	SE	0.58	0.23	0.15	0.06	0.37	0.04	0.35

SE=Standard error. N is the group sample size.

Source: Survey data

Group 1 - farm households represent those with high level of resources as compared to the sample means. We hereafter refer to this group as the high resource group (HR). Apart from poultry, these farmers also have on average larger assets than those of group 2. Group 2 - farm households are hereafter referred as low resource group (LR). Then, most of the farmers (96.41%) are in the LR group. These farmers are below the overall means for all the assets, except for poultry.

3.5. Agricultural income distribution between groups of smallholders

The agricultural income is reported for 2001. Annual gross agricultural income distribution between the two groups was analysed (Table 9). The HR group earned on

average higher agricultural income than the LR counterpart. On average, for the HR and LR groups, the agricultural income was estimated to 10,523.33 Dalasi (US$ 687.80) and 3,637.47 Dalasi (US$ 237.74), respectively.

Table 9: Gross annual agricultural income off smallholder farmers in the Gambia (Dalasi)

				95% confidence for means	
Group	N	Mean	Std. Error	Lower bound	Upper bound
HR	18	10,523.33	2,242.44	5,792.20	15,254.46
LR	483	3,637.47	2,487.14	-1,249.50	8,524.45
Total	501	3,884.87	2,399.66	-829.78	8,599.52

$1=GD15.30 (Gambia Central Bank, 2001)

Source: Estimation from survey data

Agricultural income is on average very low, but the HR group of households are better off than their counterparts in the LR group. Because the agricultural production system is still extensive, farmers rely on their resources to catch up on the productivity gap. Therefore, the more a farmer is endowed with resources the more income would be derived from agriculture. Consequently, the heads of household are involved in a variety of activities in order to generate complementary income and satisfy the household needs. The following section captures this feature.

3.6. Relationship between the household resource endowment and the types of activities

Smallholder producers in The Gambia are involved in many activities (Table 10). In particular, the heads of households in the LR group are engaged in a variety of activities. The low resource farm households are mainly occupied in three groups of activities: crop production (32%), the combination of farming and off-farm activities (31%) and the combination of farming and livestock production (23%). The off-farm activities comprise carpentry, tailoring, local bakery and care taking. Others are engaged part time in civil employment and the other in crop production (8%).

Table 10: Types of activities practiced and group membership of the household head

Activities	Group membership	
	HR group	LR group
Crop farming and off-farm activities	5	149
Off-farm activities	0	9
Crop farming and other on-farm activities	0	20
Crop farming and civil employment	1	38
Civil employment	0	1
Crop and livestock production	11	110
Livestock production	0	1
Crop production	1	153
Not stated	0	2
Independent test: chi-square=15.814; df=8; Asymptotic Significance (2-sided)=0,045		

Source: Survey data

On the other hand, the HR farm households are occupied in limited types or groups of activities. Most of them (61%) are involved in integrated crop-livestock production, and 28% are involved in crop farming and off-farm activities. Another important feature of the relationship between activity diversification and the household's resource endowment is that the HR farm households group is mostly involved in integrated crop-livestock production, while the LR ones concentrate on crop production. The Pearson's chi-square test indicates that the types of activities that the household heads are involved in and their resources endowment are not independent. There is a strong relationship (at 5% level of significance) between the household's resources and the diversification of the household's heads activities.

3.7. Needs for improved technologies and the household's resource endowment

It is well known that production is concerned with choice amongst alternative processes, namely enterprise selection and resource allocation. In this process, it is obvious that the objectives of production and the amount of investment will affect technology choice. Preceding sections have shown that income derived from

agriculture depend on the household's agriculture-related resources and that the head of household responds by diversifying his/her economic activities. It is also thought that production objectives are latent variables for technology needs at the farm household level. Each objective can be associated with a specific technology that allows for achieving it efficiently with regards to the available resources. In mixed crop-livestock production, the complexity of the system makes it difficult to disentangle objectives from technology needs.

Mixed crop-livestock farming systems apply mostly to farmers with multi-product output, because farmers are engaged in multi-purpose production processes. In order to identify needs for improved technologies, a cross-tabulation method is used to investigate the relationship between the production objectives and the latent needs for technologies as indicated by the farmers, and the resource-based farmers groups. The results are summarised in Table 11.

Table 11: Production objectives and needs for improved agricultural technologies

Technologies for	Meat production (Feeding strategies)	Milk production (Feeding strategy and crossbreeding)	Crop production (Draft power and soil fertility)
HR group[a]	14	1	3
% Within group	77.8	5.6	16.7
% Within objectives	29.20	9.10	21.43
LR group[b]	34	10	11
% Within group	61.82	18.18	20.00
% Within objectives	70.80	90.90	78.57
Overall sample[c]	48	11	14
% within group	65.8	15.1	19.2

[a] number of cases in HR group total count is 18; [b] number of case in LR group count is 483, out of which 55 cases were valid observations; [c] total valid cases in analysis is 73 corresponding to 15% of the sample.

Source: Survey data

The results indicate that in the crop-livestock production system, producing meat is the major objective of 77.8% of the farmers in the HR group who need feeding technologies to realise this objective. The second important objective (16.7% of the

HR group) is increasing crop production through the use of draft animals and the improvement of soil fertility. Increasing milk production represents the third objective as expressed by 5.6% of the HR group. Like the farmers in HR group, producing meat remains the major objective of the farmers in LR group (61.82% of the LR farmers). The second important objective is the increase of crop production, with 20% of the LR farmers. Finally, 18.18% of this group of farmers aims at increasing crop production through the use of draft animals and manure application for soil fertility management.

Within the objectives of agricultural production, the needs for improved technologies are more important in the LR group of farmers than the HR group. For improved feeding technologies to increase meat production, about 71% and 29% of the needs are from the LR and the HR group, respectively. Likewise, 91% of the needs for milk production technologies (improved feeding and crossbreeding) come from the LR group, and 9% from the HR ones. Finally, 79% of the potential demand for draft power and soil fertility technologies to improve crop production originate from the LR group, while 21% are from the HR farmers group. Although, the needs for improved technologies are more important in the LR group, it should be noticed that only few individuals in this group (55 out of 483) actually expressed their needs. Within this more resource-constrained group, 7.04%, 2.28% and 2.07% expressed their needs for meat, draft power and soil fertility, and milk technologies, respectively. On the other hand, all individuals in the HR group expressed needs for improved technologies: the majority (77.78%) need feeding technologies for increased meat production, 16.67% for draft power and soil fertility and 5.56% for milk production.

The overall results show that 73 out of 501 enumerated individuals expressed their needs for improved technologies. This represents a very low potential (14.57% of the sample) for technology transfer and adoption. As the majority of smallholders are resource-constrained, they could not benefit from improved technologies unless they are given favourable conditions to uptake them. Nevertheless, feeding technology for meat production constitutes the most attractive package for many of the smallholders. It represents about 66% of the needs. Finally, 19.2% and 15.1% of the sample farms also need draft power and soil fertility technology, and feeding strategies for milk production, respectively.

These results indicate a variety of technology development and transfer opportunities. Whether the technological progress will reach all farmers depends on the approach used in transferring technologies at farm level. Whatsoever the approach used, it should be kept in mind that smallholders are not a homogenous entity in most African countries and particularly in The Gambia.

In view of developing smallholder dairy enterprises, selected households are enumerated to evaluate the potential and constraints to milk production. The following chapters describe the local milk production *filière,* from farm level through marketing and consumption patterns.

IV. Smallholder milk production farms: An analysis per location

4.1. Socio-economic profile of the farm households' sample

A milk production survey was conducted in three divisions in The Gambia and 90 smallholder milk-oriented producers were enumerated: 46.7% in Western Division, 31.1% in Central River Division and 22.2% in Lower River Division. Table 12 shows the profile of the selected smallholder farmers engaged in milk production. The average household size ranges from 20 to 23 people depending on the geographical location. The average number of active members per farm household does not vary much between locations (11 in CRD and LRD, and 12 in WD). The Fula dominate the ethnic composition of the sample. The average distance from the farmers' location to the nearest city where milk can be sold is 8 km for farmers in the Western Division, 10 km for those in the Central River Division and 68 km for farmers in Lower River Division.

Table 12: Socio-economic profile of milk-oriented smallholder farmers' sample

Characteristics	CRD	LRD	WD
Heads of households (No. of farms)	28	20	42
Average age of household's heads (years)	48	61	54
Average household size (No. of persons)	20	23	21
Men-active (No. of persons)	6	5	6
Women-actives (No. of persons)	5	6	6
Madinka (%)	21.43	0	14.29
Fula (%)	67.86	100	42.86
Wolof (%)	10.71	0	2.38
Jola (%)	0	0	38.09
Others (Serere, Majako, etc.) (%)	0	0	2.38
Average distance to nearest city (km)	10	68	8

Notes: CRD=Central River Division; LRD=Lower River Division; WD= Western Division.
Source: milk production survey (2001)

Most of the respondents were cattle owners (only 2.2% of the sample own crossbreeds, for this process is relatively new with support from the International Trypanotolerance Centre, ITC). Milk-oriented producers are from various socio-professional categories, but the majority of them are typical farmers (97%). Civil servants (2.2%) and traders (1.1%) are also involved in milk production. Three decision centres were identified: in 71% of cases only the cattle owner is responsible for decisions regarding technical interventions on cattle. The decision-making process can involve also both the cattle owner and the herder (19% of the sample), or the herder alone is authorised to take decisions (10%). In The Gambia, Producer Associations exist and about 40% of the sample was members of the Livestock Farmers Association. Forty-eight percent of the enumerated farmers were educated either in local and Arabic language (33.3%), or formal education (13.3%) or simply alphabetised (1.1%).

4.2. Breeding stock of smallholder dairy farms

Assets are divided into three categories: current, intermediate and long run. Current assets consist of cash and other property that will be converted into cash through the normal operation of the farm during the year, such as sale of livestock. Intermediate assets include short-lived capital resources used in farm production, such as breeding stock and equipment. Long-run assets are permanent and consist primarily of farmland and buildings. Table 13 summarises breeding stock owned by milk-oriented smallholders.

Table 13: Average breed composition (heads) of smallholder milk production farms

	CRD		LRD		WD	
Breed composition	Average	SD	Average	SD	Average	SD
N'Dama Gambia	40.64	31.64	85.65	52.41	44.57	38.42
N'Dama Gabu/Futa	9.54	21.66	0.30	1.34	3.38	15.43
Zebu Gobra	0	0	0	0	0.05	0.31
Crossbreed1	0.14	0.59	0.10	0.45	0.17	0.93
Crossbreed2	0.00	0.00	0.00	0.00	0.05	0.31
Sample size	28		20		42	

Crossbreed1 and Crossbreed2 represent N'Dama*Zebu Gobra and N'Dama*European breed crossed, respectively.

Source: milk production survey (2001)

The cattle stock is composed of five breeds unequally distributed. The most important is N'Dama cattle divided into sub-groups: the Gambia N'Dama and N'Dama Gabu and/or Futa. These breeds are found all over the country. Zebu breed is only found in the Western Division with a small number owned per household. The large standard deviation associated with a small average number indicates the existing inequality of owning Zebu, for this trypanosusceptible breed is recently introduced in areas with low tsetse challenge. Likewise, the introduction of N'Dama and European breed crosses (Jersey or Friesian) at farm level has just started with the assistance from ITC. On the other hand, the Zebu crossed N'Dama is found in all three divisions.

However, few numbers of this crossbred are available and unequally allocated between farm households.

4.3. Herd structure of smallholder dairy farms

Table 14 summarises the herd structure of the smallholder milk-oriented farms per location. In the Central River Division (CRD), the three year old cattle are predominant in the herd structure, both for female and male cattle. Of second importance are animals of 1 to 2 years old in the case of male, and animals aged of less than one year for the female category. The third category of importance is constituted by animals of less than one year old, and of 1 to 2 years, in the male and female category, respectively. The cattle herd sex-age structure is highly variable, irrespective to the location of the production unit.

Table 14: Average herd's structure (heads) of smallholder milk-oriented farms

	CRD		LRD		WD	
Herd structure	Average	SD	Average	SD	Average	SD
Male of 0-1 year	4.25	2.94	9.65	8.05	4.40	4.19
Male of 1-2 years	5.14	4.37	8.25	7.66	3.43	4.74
Male of 2-3 years	3.43	2.30	7.15	4.72	1.79	2.73
Male over 3 years	5.29	4.47	6.30	3.84	1.83	1.77
Female of 0-1 year	5.96	4.82	11.10	6.11	7.93	8.01
Female of 1-2 years	5.43	3.81	8.30	6.19	5.10	6.15
Female of 2-3 years	5.14	3.49	11.70	12.49	4.10	4.32
Female over 3 years	13.96	10.61	23.60	14.32	19.33	17.43
Sample size	28		20		42	

Source: milk production survey (2001)

Another important feature of the herd structure is that females are in general more important than the males. On average cattle herds are constituted of 62.74% females in CRD, 63.57% and 62.74% in LRD and WD, respectively. Reproductive females (over 3 years old) account for 45.79%, 43.14% and 53.02% of total females in

the herd in CRD, LRD and WD respectively. Farmers therefore seem to place more attention to the herd reproduction and only subsequently to milk production.

4.4. Cattle feeding strategies of smallholder dairy farms

The results indicate that animal feeding is mainly based on natural pasture. The average grazing time is 7, 8 and 9 hours per day in the Western, Lower River and Central River Divisions, respectively. Some categories of animals are kept under stabling and fed with fodder trees and crop residues. Table 15 shows the frequencies of farmers allocating complementary feeds to animals. The results show that more attention is given to feeding draft animals. About 71%, 75% and 19% of the enumerated farmers in CRD, LRD and WD respectively provided complementary feed to draft cattle. Lactating cows are mostly left to grazing and are complemented when returning from pasture feeding.

Table 15: Frequencies of farm households supplementing per category of cattle

	CRD		LRD		WD	
	No. farmer	%	No. farmer	%	No. farmer	%
Draft cattle	20	71	15	75	8	19
Lactating cows	1	3.57	-	-	2	4.76
Sick animals	-	-	-	-	1	2.38
Calves	3	10.71	1	5	-	-

- = not mentioned.

Source: milk production survey (2001)

Feed resources in the study areas are concentrates from local milling units (groundnut cake, millet bran and rice bran) and crop residues (groundnut hay), as shown in table 16. These feeds are available all over the country, but whether they are used to feed cattle depends on the farmer's decision and the existing alternative utilisation at the household level.

Table 16: Utilisation of feed resources by farm households sample to feed cattle

	CRD		LRD		WD	
	No. farmer	%	No. farmer	%	No. farmer	%
Groundnut cake	20	71.43	-	-	-	-
Rice bran	8	28.57	3	15	-	-
Millet bran	8	28.57	3	15	-	-
Groundnut hay	2	7.14	16	80	9	21.43

- = not mentioned.

Source: milk production survey (2001)

In CRD, groundnut cake is most frequently fed to cattle (71.43% of the sample). Farmers reported procuring it from local milling units as well as from Senegal, the neighbouring country. Other feed resources include rice bran (28.57%), millet bran (28.57%) and groundnut hay (7.14%) for feeding cattle. In LRD, groundnut hay represents the most frequent feed supplement for cattle (80% of the sample). Rice and millet bran is also used by 15% of the interviewed farmers. Finally, only groundnut hay is cited as a feed resource used by a very little number (21.43%) of farmers in WD to supplement cattle.

4.5. Cattle health care patterns in smallholder dairy farms

Table 17 shows frequency of diseases affecting livestock in the study areas. Farmers, irrespective of the location in the 3 divisions, have listed a wide range of diseases. The results indicate that in the 3 divisions, trypanosomosis has frequently occurred in the herd of milk-oriented smallholders, in particular in the LRD. Blackquarter is indicated as the second most frequently occurring disease in LRD, while it is as frequent as trypanosomosis in CRD and WD. Other diseases of importance are: foot and mouth disease, tick and tick-borne diseases, and scouring.

Table 17: Frequencies of disease occurrences in smallholders milk-oriented.

	CRD	LRD	WD
Black quarter	31.40	27.27	34.25
Foot and mouth disease	19.77	15.91	1.85
Trypanosomosis	31.40	43.18	34.26
Foot rot	5.81	0	1.85
Tick and tick-borne diseases	8.14	2.27	1.85
Scouring	2.33	6.82	17.59
Tuberculosis	1.16	0.00	0.00
Small ruminant plague	0.00	2.27	0.00
Valid observations	86	44	108

Source: milk production survey (2001)

To combat these diseases, farmers use either traditional, or modern treatment or combine both. The amount of money invested in livestock healthcare, together with some accessibility-related constraints are given in Table 18. The results indicate that annual costs of disease treatment vary according to the divisional location of the production units. The farther the farmer is located with respect to the location of the Department of Livestock Services (DLS- the major supplier of veterinary services), the higher the investment incurred. Thus farmers in the WD pay less than their counterparts in CRD and LRD for treating their animals. For example, veterinary expenditures are 1.72 and 1.85 times higher in CRD and LRD, than in WD.

Table 18: Average annual costs of disease treatment and accessibility issues

	CRD	LRD	WD
Annual costs (and SD) in Dalasis	487.43 (88.61)	522.60 (99.69)	282.69 (79.78)
Accessibility issues of veterinary products (%)			
Product shortage	15.38	52.17	12.82
Expensiveness of products	46.15	13.04	43.59
Product shortage and expensiveness	38.46	17.39	10.26
Little accessibility to products	0.00	17.39	33.33
Valid observations	26	23	39

Source: Milk production survey (2001)

There are two reasons for the high cost veterinary products: availability and accessibility. The most important issue mentioned in relation to the availability of veterinary products is their shortage in LRD (69.56% of the sample). This issue is less perceived in CRD (53.84%) and in WD (23.08%). On the other hand, accessibility is the major limiting factor that influences cost of veterinary products in WD (33.33%), while it is not much perceived by farmers in LRD (17.39%). The combination of accessibility and availability lead to high cost of veterinary products as generally perceived by farmers. The evaluation of farmers' perception on the cost of these products indicates that 84.61% (CRD), 53.85% (WD) and 30.43% (LRD) of the sample consider that veterinary products are expensive.

4.6. Milk off-take in smallholder dairy systems

The quantity of milk produced at farm level depends on a variety of factors. Apart from technical (feeding, health) and the genetic factors, milk production is affected by other factors such as the lactating stock, the season of calving that determines feed availability, management factors (milking), etc. Table 19 shows some major factors that influence milk production in smallholder dairy production systems.

The results indicate that the stock of lactating cows was quite stable from the dry season to the rainy season. An average of 8 cows was lactating in the CRD in both dry and rainy season. In the LRD and WD lactating stock increased by one and 3 heads, respectively. Furthermore farmers in LRD kept more lactating cows and consequently milked more cows than their counterparts in WD and CRD. Most of the lactating cows were milked in all 3 divisions during both the dry and rainy season. On average, the number of milkings per day did not vary between dry and rainy season in LRD (once a day) and WD (twice a day). On the other hand, farmers in CRD were milking cows once a day during the dry season and twice in the rainy season.

Table 19: Average characteristics of milk production and utilisation

	CRD		LRD		WD	
	Mean	SD	Mean	SD	Mean	SD
Lactating cows in dry season (heads)	8.18	5.81	15.60	8.79	8.81	7.72
Lactating cows in rainy season (heads)	8.07	4.02	16.95	8.36	12.05	11.00
Cows milked in dry season (heads)	6.75	5.60	14.55	9.48	8.67	7.51
Cows milked in rainy season (heads)	7.89	4.08	16.45	8.21	11.14	9.73
No of milking in dry season (per day)	1.14	0.76	1.05	0.22	1.55	0.55
No of milking in rainy season (per day)	1.93	0.26	1.40	0.50	1.67	0.48
Milk produced in dry season (l/cow/d)	0.42	0.26	0.58	0.34	0.70	0.27
Milk produced in rainy season (l/cow/d)	1.54	0.43	1.60	0.35	1.69	0.37
Milk consumed in dry season (l/hh/day)	1.55	1.28	3.00	1.55	2.14	1.13
Milk consumed in rainy season (l/hh/day)	3.84	2.10	3.98	1.01	2.94	1.23
Milk sold in dry season (l/hh/day)	1.29	2.90	7.50	7.37	4.65	4.88
Milk sold in rainy season (l/hh/day)	8.07	5.90	18.58	13.33	12.10	13.60
Target milk quantity before sale (l/hh/day)	5.73	4.90	4.63	2.41	2.56	1.14

Notes: l/hh/d=litre/household/day; l/cow/d=litre/cow/day.

Source: Milk production survey (2001)

The results also indicate that the average daily milk off-take per cow varies between the dry and rainy season. In the dry season, milk off-take was estimated at 0.42, 0.58 and 0.70 litres per cow per day in CRD, LRD and WD, respectively. This quantity increases in the rainy season to almost 2 litres in all 3 divisions.

In the mixed crop-livestock farming systems, the quantity of milk off-take is either self-consumed, or sold. On average, daily milk production per household in CRD is estimated at 3 and 12 litres during the dry and rainy seasons, respectively. In LRD, the average daily production per household is 11 litres in the dry season and 23 litres in the rainy season. In WD, daily milk production averages 7 and 15 litres per household in the dry and rainy season, respectively.

Farmers in LRD are supplying more milk to the market than those in WD and CRD. During the dry season, an average of almost 8 litres are sold per household in the LRD as compared to about 5 and 1 litres supplied per household in WD and CRD,

respectively. As expected, the amount of milk supplied increases during the rainy season, because more feed is available. This increase is twofold, threefold and sixfold in LRD, WD and CRD, respectively.

Finally, most of the interviewed farmers aim at increasing milk production in order to increase their home-consumption (nutritional purpose) and their marketable surplus (income purpose). Therefore, there exists competition between subsistence and market-oriented objectives in the smallholder milk producer's household. To evaluate what would be the impact of increasing milk production, farmers were asked about the amount of milk they are targeting for home-consumption before participating in marketing. The results indicate that farmers in WD are close to achieving the target quantity for home-consumption. They are currently consuming 2.14 and 2.94 litres in the dry and rainy season, respectively, and the target quantity is evaluated to 2.56 litres. An increase in milk production would likely be oriented to marketing. On the other hand, the current home-consumption in CRD (at most 3.84 litres) and LRD (3.98 litres) is far away from the target quantity (5.73 litres and 4.63 litres, respectively in CRD and LRD). An increase of milk production would therefore likely be shared between home-consumption and marketing.

V. Typology of smallholder milk producers: A resource-based analysis

To yield valuable insight into the rationale for milk production, and thus for analysis aimed at policy design and implementation to improve this system, it is worth to address its microeconomic foundations. As argued by Johnston and Kilby (1975), agriculture is no different from other sectors of the economy in that specialisation (and the ensuing trade) is the "mechanism" driving productivity growth and income expansion. Establishing microeconomic foundations allows analysing milk production units as enterprises. This led to a resource-based approach to typifying smallholders and analysing the economic returns of milk production.

Eight types of milk-related resources were used to discriminate between smallholders: the household active members, the farm size, the cost of intermediate assets (farming and milk production equipment), the number of cattle (disaggregated

into Gambian N'Dama, N'Dama from Bissau, European breeds crossed with N'Dama, Zebu crossed with N'Dama, and Zebu Gobra).

5.1. Resource-based types of smallholder milk producers

The results from K-Means cluster analysis and Discriminant analysis indicate milk producers can be divided into two groups (Table 20) of unequal size: a small group of farmers representing 19% of the sample and a large group corresponding to 81% of the sample. On average, the latter group owns fewer resources than the former. In the following sections, we refer to farmers that belong to the large group as low resource (LR), and to those in the small group as high resource (HR).

Significant discriminanting variables are the cost of intermediate farm assets at 1% level, farm size and the number of Gobra cattle at 5% level. Other farm assets (the number of Gambian N'Dama, Bissau N'Dama, European breeds crossed with N'Dama, Zebu crossed with N'Dama) are not significant.

Table 20: Test of equality of group means

Variables	Wilks' lambda	F	Df1	Df2	Significance
Household active members	0.977	2.085	1	88	0.152
Farm size	0.951	4.555	1	88	0.036**
Cost of intermediate assets	0.241	277.585	1	88	0.000***
N'Dama cattle	0.987	1.175	1	88	0.281
Crossed exotic cattle	0.997	0.231	1	88	0.632
Crossed Gobra cattle	1.000	0.027	1	88	0.870
Pure Gabu or Futa cattle	0.986	1.293	1	88	0.259
Zebu Gobra cattle	0.952	0.952	1	88	0.038**

, * Significant at 5% and 1%, respectively.

Source: Milk production survey (2001)

The test of equality of group means indicates significant difference between LR and HR groups in the endowment of land (farm size), the investment in farming and milk production equipment (cost of intermediate assets) and the number of Zebu

Gobra. The discriminant analysis therefore yielded one canonical function with an Eigenvalue of 3.154 and 87% of canonical correlation. The estimated Wilks' Lambda for this function was 0.241 (chi-square = 124.614, and DF = 1).

5.2. Herd structure of the two types of smallholder milk producers

Table 21 shows the average herd structure of the smallholder milk producers. Female cattle aged over three years are predominant in the herd of both groups of smallholders. Secondly, high numbers of female calves (< 1 year) are kept in the herd, irrespective of the group of farmers. For the male cattle, the results indicate that numbers are decreasing with age. Few male cattle aged over 3 years are kept in the herd for both groups. On the other hand, more male calves were reported.

Table 21: Comparative herd structure of smallholders in the Gambia

Clusters	Female cattle (heads)				Male cattle (heads)			
	< 1 year	1-2 years	2-3 years	>3 years	< 1 year	1-2 years	2-3 years	>3 years
High (17)								
Min.	2	0	0	0	1	0	0	1
Mean	11	8	7	23	7	7	4	5
Max.	26	19	19	64	34	27	11	20
SE	1.85	1.32	1.33	5.14	1.91	1.73	0.82	1.23
Low (73)								
Min.	0	0	0	0	0	0	0	0
Mean	7	5	6	18	5	5	3	4
Max.	38	25	60	66	22	27	20	18
SE	0.78	0.66	0.91	1.57	0.55	0.61	0.45	0.39
Overall (90)								
Min.	0	0	0	0	0	0	0	0
Mean	8	6	6	19	6	5	3	4
Max.	38	25	60	66	34	27	20	20
SE	0.73	0.59	0.78	1.60	0.57	0.59	0.39	0.40

Values in parenthesis are number of observations. Source: Milk production survey (2001)

However, these central measures mask the heterogeneity of the herd structure. The estimated coefficients of variation (CV) indicate a strong variability in the herd structure within groups and between groups as well. In the HR farm households group, coefficients of variation of 0.94, 0.79, 0.71 and 0.70 are found for female cattle of over 3 years, 2-3 years, less than 1 year, and 1-2 years, respectively. For male cattle, values of 1.09, 1.03, 0.93 and 0.84 are found for age group of less than 1 year, 1-2 years, over 3 years and 2-3 years old, respectively.

In the LR farm households and for female cattle, the high variation in herd structure is found for females aged of 2-3 years (CV = 1.32), and those of 1-2 years (CV = 1.03). Coefficients of variation of 0.90 and 0.76 are estimated for females aged less than 1 year and over 3 years, respectively. High variability is also found in male cattle of 2-3 years old owned by farmers (CV = 1.15), and of 1-2 years old (CV = 1.14). Finally, the coefficients of variation of male cattle aged over 3 years and less than 1 year are 0.96 and 0.91, respectively.

The between group variation show that except for female cattle over three years, the herd structure of the LR farm households is more dispersed than that of the HR ones. Note the similarity between both LR and HR group of farmers in terms of the qualitative composition of their cattle herd. In general, more females of over three years old are kept by both groups, this could mean that irrespective to the amount of resources, reproduction and subsequently milk production constitute livestock owners' primary objectives.

5.3. Herd structure and milk production management

The herd structure has implication on milk production, because dairy cows are a portion of the reproductive cows. Table 22 shows results on the number of milked cows and the number of daily milkings during both rainy and dry season. On average, 57% and 61% of the reproductive cows were milked in the HR farm households' herds during the dry and rainy season, respectively. In the LR farm group, 48% and 61% of the cows over three years were milked in dry and rainy season, respectively. All

smallholder dairy production units are labour intensive where milking is done by hand, once a day during the dry season and twice in the rainy season.

Table 22: Average number of milked cows and daily milking

Groups	Dry season		Rainy season	
	Milked cows (head)	Daily milking	Milked cows (head)	Daily milking
High-level	**17**	**17**	**17**	**17**
Minimum	0.00	0.00	2.00	1.00
Mean	12.94	1.12	13.88	1.76
Maximum	28.00	2.00	50.00	2.00
SE	2.21	0.19	3.04	0.11
SD	9.12	0.78	12.53	0.44
Low-level	**73**	**73**	**73**	**73**
Minimum	0.00	0.00	1.00	1.00
Mean	8.55	1.36	10.71	1.67
Maximum	33.00	2.00	35.00	2.00
SE	0.87	0.07	0.85	0.06
SD	7.47	0.56	7.28	0.47
Overall	**90**	**90**	**90**	**90**
Mean	9.38	1.31	11.31	1.69
SE	0.84	0.64	0.89	0.05
SD	7.94	0.61	8.52	0.47

Source: Milk production survey (2001)

In general, the quantity of milk home consumed and sold varies from dry to rainy season (Table 23). In the rainy season, the home consumption was evaluated as two (2) litres per household for both groups of farm households. In the dry season, the HR farm households consumed slightly more milk than the LR ones (4 and 3 litres/household, respectively). The results do not show any difference on milk self-consumption between the two groups of farm households.

Table 23: Average quantity of milk self-consumed and sold per day

Groups	Dry season		Rainy season	
	Home-consumed (litres)	Sold (litres)	Home-consumed (litres)	Sold (litres)
High-level	**17**	**17**	**17**	**17**
Minimum	0.00	0.00	2.00	0.00
Mean	2.03	6.29	3.91	17.47
Maximum	5.00	25.00	12.00	75.00
SE	0.39	1.84	0.56	4.48
SD	1.61	7.59	2.32	18.48
Low-level	**73**	**73**	**73**	**73**
Minimum	0.00	0.00	0.50	0.00
Mean	2.18	3.76	3.34	11.08
Maximum	6.00	25.00	6.00	38.00
SE	0.15	0.57	0.16	1.17
SD	1.31	4.83	1.34	9.97
Overall	**90**	**90**	**90**	**90**
Mean	2.15	4.24	3.45	12.28
SE	0.14	0.58	0.17	1.28
SD	1.37	5.51	1.57	12.17

Source: Milk production survey (2001)

On the other hand, the estimated daily amount of milk sold differs between groups. The HR farm households sold on average six (6) litres/household in the dry season. Likewise, in the rainy season, they sold 17 litres/household while the overall average was 12 litres/household. In the LR farm households, the daily milk sale was estimated at 4 litres/household and 11 litres/household during the dry and rainy season, respectively. However, the quantity of milk sold varies among households as indicated by the larger coefficient of variation. The variation within LR farm households was more important in the dry season (CV = 1.29) than in the rainy season (CV = 0.90). The most important variation was found within the HR farm households, with

coefficients of variation evaluated at 1.21 and 1.06 in the dry and rainy season, respectively.

5.4. Reproduction parameters influencing milk production

Table 24 summarises some reproduction parameters reported by farmers. The average age at the first covering of a heifer born in the herd, slightly differs between the two groups of farm households. On average, the first covering was around 40 months as reported by the HR group with 36 and 48 months for lower and upper bounds, respectively. The within-group variation was however very low (CV = 0.14).

Table 24: Some reproduction parameters affecting milk production

Group statistics	Heifer's age at the first covering (months)	Heifer's age at the first calving (months)	Inter-calving period (months)
HR	17	17	17
Minimum	36.00	48.00	12.00
Mean	39.53	51.53	20.82
Maximum	48.00	60.00	30.00
SE	1.37	1.37	1.27
SD	5.64	5.64	5.25
LR[a]	69	69	69
Minimum	24.00	36.00	12.00
Mean	37.74	49.74	20.09
Maximum	48.00	60.00	48.00
SE	0.62	0.62	0.95
SD	5.16	5.16	7.86
Overall	86	86	86
Mean	38.09	50.09	20.23
SE	0.57	0.57	0.79
SD	5.27	5.27	7.39

[a] four missing values reported.

Source: Milk production survey (2001)

In the LR group, this variable averaged 38 months, with minimum and maximum age evaluated to 24 and 48 months, respectively. The within-group variation was 0.14. Overall, the average heifer's age at the first covering was evaluated at 38 months, 50 months at the first calving and 20 months for the inter-calving period.

VI. Economics of smallholder dairy production units

6.1. Dairy products supply and marketing

Milk supply and marketing at the farm level depends on the quantity targeted for home consumption, which in turn determines the surplus that can be sold. Table 25 shows the average targeted quantity of milk for home consumption. On average, the farm household in the LR and HR groups target 4 and 5 litres for home consumption, respectively.

Table 25: Targeted quantity of milk (litres) for home consumption

Statistics	HR	LR	Overall
Minimum	2.00	0.50	0.50
Mean	5.00	3.77	4.00
Maximum	15.00	20.00	20.00
SE	0.78	0.39	0.35
SD	3.24	3.34	3.34

Source: Milk production survey (2001)

In addition, milk supply and marketing are influenced by environmental factors, such as the season, the location of the farm with regards to marketing points and the availability of transportation equipment, etc. The majority of farm households (65.6%) sell their dairy products throughout the year, and 27.8% only during the rainy season. Dairy products are therefore available year round. These products comprise fresh milk (55.6% of farm households), sour milk (5.6%) and both fresh and sour milk (31.1%).

In general, dairy products were sold at the farm gate (74.4% of cases), while 15.6% of milk producers sold their products at market places or near the homestead and 2.2% at both locations. Several means of transport were also used to take dairy

products to the markets. Recycled containers of different capacities (5 to 20 litres) are filled with dairy products and carried to the markets by foot, bicycle, motorcycle or vehicle. The delivery distances vary from 1 to 14 km, with an average of 6 km (SE = 1.07; SD = 4.16). Dairy products are directly sold either to consumers in 37.8% of cases, or to others (collectors and resellers) in 54.4% of cases.

Pricing for dairy products at the farm gate is based on bargaining. Although prices are set according to the season of the year, the relationship between sellers and buyers greatly influences the effective sale price.

6.2. Economic performance of smallholder milk producers

Maximising profit while producing at a higher level of efficiency is a goal cherished by most smallholder dairy farmers. An important question to examine is therefore the farm household production economics in terms of production potential, and maximum attainable income for the farm household.

Table 26 presents the farm partial budget based on the accrual methods of accounting. The results indicate that smallholder dairy farms were operating efficiently.

Table 26: Partial budget statement (Dalasis) of smallholder dairy farms in 2001

	HR group	LR group
Farm operating income		
Sale of dairy products (1)	16,355 (4,018)	10,230 (1,117)
Farm operating expenses (2)		
Feed	39.71 (21.74)	46.78 (17.76)
Veterinary products	557.29 (74.51)	390.23 (31.13)
Net cash operating income (3) = (1-2)	15,758 (4,012)	9,793 (1,117)
Value of dairy products consumed by household (4)	4,034 (497)	3713 (183)
Value of sales and consumption (5)= (3+4)	19,792 (4,125)	13,506 (1,187)
Opportunity cost of labour (herdsmen) (6)	2,787 (167)	2,621 (74)
Gross margin (7) = (5-6)	17,006 (4,194)	10,886 (1,190)

Values in parenthesis are standard errors. 1$US =15.30 Dalasi

Source: Milk production survey (2001)

On average, the HR farms earned 1,313 Dalasis a month in net cash operating income, while the LR earned 816 Dalasis. In terms of economic profitability, both LR and HR farm households engaged in milk production earned a profit. However, these results indicate high variability because some farms were losing money. For the net cash operating income, the coefficients of variation were evaluated to 1.05 and 0.97 within the HR and LR farm households, respectively. In the former group, the minimum and maximum net cash operating income were –905.00 and 59,010.00 Dalasi/household/year. On the other hand, the minimum and maximum net cash operating income earned in the LR group were –1,210.00 and 36,120.00 Dalasi/household/year.

Likewise, high coefficients of variation were estimated for the gross margin – GM- (1.02 within HR farms, and 0.93 within LR). The minimum gross margin (-2,048 Dalasis/household/year) was found within the HR farm households, the maximum gross margin being 60,282 Dalasi. Within the LR ones, the minimum gross margin was –1,739.00 Dalasi, and the maximum being estimated at 37,490 Dalasis/household/year.

For the overall sample, milk production units earned 10, 920 Dalasi per annum on average, as net cash operating income (SE =1,194). The average gross margin was evaluated at 12,041 Dalasi (SE = 1,262). Earnings from dairy production are however widely distributed between smallholder milk producers. Thus, the coefficients of variation for the net cash operating income and the gross margin are 1.03 and 0.99, respectively.

6.3. Economic viability of smallholder milk production

The analysis of enterprise viability was based on some indicators. The gross margin (GM) and the net cash operating income (NCOI) were used as the basis of analysis in evaluating smallholder dairy farm units. Viability assessments were based on the gross margin per unit of production. Under consideration was the gross margin per cow (GM/cow and NCOI/cow). The gross margin per variable costs (GM/VC and NCOI/VC), representing the returns per each invested Dalasi, was also considered.

Table 27: Comparative dairy enterprise average gross margin for 2000/2001

Viability indicators	HR	LR	Overall
Net cash income per cow (Dalasi/cow)	491.87 (76.70)	527.99 (56.68)	521.17 (48.06)
Net cash income per variable cost	5.34 (1.47)	3.39 (0.38)	3.76 (0.42)
Gross margin per cow (Dalasi/cow)	507.57 (91.36)	584.91 (82.71)	570.30 (69.16)
Gross margin per variable cost	5.77 (1.56)	3.79 (0.42)	4.16 (0.45)
Net cash income per litre (Dalasi/litre)	4.56 (0.52)	4.83 (0.21)	4.78 (0.19)

1$US=15.30 Dalasi.

Source: Milk production survey (2001)

On average, the net cash income per cow and the gross margin per cow of the LR farm household group are higher than those of the HR group. The former group has invested more in feed and less in veterinary products than the latter. In terms of cost-effectiveness (net cash/variable cost), the results revealed that the LR farm households were therefore more cost-effective. Their cash return was estimated at 4.83 Dalasi versus 4.56 Dalasi for the HR farms. For the overall sample, the results established that smallholder dairy farms are financially and economically viable.

On average, a producing dairy cow generated 521.17 Dalasi/household/year in the overall sample. Due to low investments, the prices of dairy products at farm level are slightly above the marginal cost of production. Considering feed (produced and purchased), veterinary products and labour, the estimated costs for producing a litre were 2.27 Dalasi (SE = 0.65) and 2.16 Dalasi (SE = 0.24) for the HR and the LR dairy farms, respectively. At the same time, the minimum sale price for milk and milk products was established at 5 Dalasi/litre.

VII. Analysis of dairy products marketing patterns

7.1. Socio-economic characteristics of local dairy products sellers

Local milk marketing systems function in a framework of a free-market. We did not find restrictions for any economic agent to operate in this sub-sector, nor formalised milk marketing. Table 28 shows some socio-economic characteristics of milk sellers in Western Division.

Table 28: Characteristics of milk sellers in the markets of the Kombos and Kanifing

	Men	Women	Total observations
Fula ethnic	13	51	64
Jola ethnic	0	7	7
Total observations	13	58	71

Source: Milk marketing survey (2001)

The results show that both men and women are found in milk marketing systems. However, women (81.69% of sellers) are predominantly handling this activity. Two ethnic groups are met; proving that milk marketing is not ethnically based, although the Fula ethnic group is the majority.

7.2. Local milk marketing structure and conduct

Three structures of milk marketing were identified during the survey. First, farmers supply directly to sellers. Secondly, milk collectors procure the products from farmers and supply the sellers. However, there exists no formal organisation of collectors, and most of them operate only occasionally. The third structure is a combination of the two. Irrespective of the structure, milk marketing is based on a certain confidence between the suppliers (farmer, collector or both) and the sellers (retailers). In the Kombo and Kanifing markets (Serrekunda, Fagikunda, Brikama, etc.) milk is procured from various locations as shown in Table 29.

Table 29: Milk marketing structure descriptions in Kombo and Kanifing

Descriptors	Number of observations	Percent
Milk supply location against the market		
0-1 km	6	8.45
2-5 km	3	4.23
Over 5 km	62	87.32
Categories of milk suppliers		
Farmers	12	16.90
Collectors	54	76.06
Farmers and collectors	5	7.04
Number of observations	71	

Source: Milk marketing survey (2001)

According to the categories of milk suppliers, different locations of milk supply were identified. The results indicate that most milk sellers relied on suppliers located over 5 km away. These suppliers are located either in the Western Division (Brikama, Siffoe, Kuloro, Faraba, Bulock, Nyofelleh, Sangajor and N'demban), in the Lower River Division (Kantong Kunda, Niono Jattaba and Kuli Kunda), or in Kanifing Municipality (Serrekunda, Latrikunda and Kanifing).

Two types of milk and dairy products are bought from the suppliers: raw and sour milk. On the other hand, three types of milk and dairy products are sold to consumers: local cream, raw and sour milk. That means the milk marketing also involves processing. About 19% of sellers have processed raw milk to extract local cream. In general, sellers are supplied with sour milk (60.23% of sellers). Table 30 summarises the types of dairy products usually sold.

Table 30: Kind of milk products supplied to sellers and sold to consumers

	Number of observations	Percent
Milk products supplied through sellers		
Raw milk	18	25.35
Sour milk	36	50.70
Raw and sour milk	17	23.94
Milk processed by sellers		
No	52	73.24
Yes	19	26.76
Milk products sold to consumers		
Raw milk	16	22.54
Sour milk	27	38.03
Raw and sour milk	13	18.31
Cream and sour milk	10	14.08
Cream, raw and sour milk	5	7.04

Source: Milk marketing survey (2001)

Results in Table 30 indicate that sour milk is the most commonly sold milk product. In an individual product analysis, 52.88% of the sellers sell sour milk to

consumers. About 32.69% and 14.42% of sellers sell raw milk and local cream, respectively. Some sellers diversify their activity by selling two (raw and sour milk or cream and sour milk) or three products (cream, raw and sour milk).

7.3. Economic performance of local milk marketing systems

Maximising profit is a goal cherished by all milk sellers in the local context. From an economic point of view and for the discerning seller of paramount importance is not to provide milk to consumers but in dealing with this in relation to the activity's viability. The gross margin analysis was based on the daily operation per unit (litre) and in relation to the market structure. The marketing cost structure was evaluated. The results are presented in table 31.

Table 31: Dairy marketing costs structure and gross margin in Kombo and Kanifing per day

Source of procurement	Farmers		Collectors		Both	
Indicators	Average	SD	Average	SD	Average	SD
Quantity purchased (litres/day)	34.17	37.22	40.59	28.31	51.00	13.87
Purchase costs (D/day)	192.08	299.82	208.15	144.84	248.00	67.38
Transport cost (D/day)	12.08	24.44	4.75	8.97	20.40	5.55
Turnover (D/day)	283.58	385.27	274.17	178.86	352.20	104.67
Gross margin/operation (D/day)	79.82	82.19	61.26	45.81	83.80	33.88
Gross margin/litre (D/l)	2.71	2.60	1.59	0.77	1.61	0.26

1$US=15.30 Dalasi (D).

Source: Milk marketing survey (2001)

Milk marketing has great potential economic benefit for sellers. The results indicate positive gross commercial margins for all marketing structures. Sellers operating directly with farmers gain the higher unit benefit, about 2.71 Dalasi. When an intermediary (collector) is considered, the gross margin decreases by 41.33%. Combining the two structures, allows sellers to keep the gross margin level at 40.59% lower than operating directly with farmers.

Although the operations of milk collectors reduce the sellers' benefits, they help to reduce transport cost per operation. Sellers brought transport cost down to 60.66% of the transport cost of operating directly with farmers. This cost rises when sellers combine the two approaches to milk marketing. Another important role of collectors is their contribution in increasing the quantity of milk supplied to sellers per operation, up to 18.79% compared to that directly delivered by farmers to sellers.

7.4. Seasonality of local milk marketing economic performance

Seasonality affects milk marketing. In rural settings most indigenous cows calve during the rainy season, which provides consumers with a source of milk. The perception of milk sellers on the seasonality of the milk price was evaluated. Table 32 summarises seasonal milk marketing differences according to the change in prices.

Table 32: Sellers' perceptions of seasonal volatility of milk prices in the Kombo and Kanifing

Low price level of milk (N=71)		High price level of milk (N=71)	
Periods	% of respondent	Periods	% of respondent
July to January	42.25	February to June	43.66
July to March	45.07	April to July	11.27
August to January	1.41	April to June	45.07
August to March	11.27	_____	_____

N= total number of respondent.

Source: Milk marketing survey (2001)

Sellers perceive the seasonality of milk price levels differently depending on how easily they are supplied with milk all year and at which price. For the majority of sellers (87%), milk prices start decreasing in July because of increases in milk production. The length of the period when low milk prices prevail is variable, ending in January for 42.25% of sellers, and in March (for 45.07%). Hence, the period for low prices can last 6 to 9 months. Likewise, the period during which milk prices are perceived as higher is also variable. Most of the sellers perceived high prices as starting in April (56.34%) while 43.66% perceived them as starting as early as

February. The implication of price volatility on the economic performance of milk marketing was also assessed (Table 33).

Table 33: Seasonal economic performance of milk marketing in the Kombo and Kanifing (D/litre)

	Low price period		High price period	
Types of milk products	Average	SD	Average	SD
Raw milk	1.96	1.96	2.24	2.24
Sour milk	1.58	0.71	1.92	0.76
Raw and sour milk	1.75	0.5	1.43	0.85
Local cream and sour milk	1.86	0.54	1.94	0.40
Local cream, raw and sour milk	1.89	0.36	1.89	0.55

Source: Milk marketing survey (2001)

In general, the unit gross margin increases during the period of milk scarcity, associated to high milk prices; the low price period being associated with the period of milk abundance. The magnitude of increases in gross margin varies with the type of milk products or combination of products with which the seller is operating. For sellers of a single milk product, increases of 21.52% and 14.28% in gross margin were obtained in sour and raw milk sales, respectively. Milk price volatility also generates increases in the gross margin of sellers of multiple products. This is the case of raw and sour milk sellers with 18.29% rise in gross margin, as well as for local cream and sour milk dealers (4.30%). Lastly, in most cases of diversified milk products (up to 3 products) sold, this has yielded stable gross margins.

7.5. Marketing systems of imported dairy products

Results of a survey at the formal selling points (shops, mini and super markets) are reported in Table 34. It is shown that powder and concentrated milk are the most demanded products at any of the selling points. On average, 4137 kg and 3747 kg of concentrated and powder milk is respectively sold monthly by the enumerated sample. Note that very small quantities of UHT, flavoured milk and yoghurt are sold in other

shops as compared to super and mini-markets. This is because these dairy products require adequate and more sophisticated storage conditions, which are generally lacking in other small shops. The total monthly supply by the sample is estimated to 735, 375, and 244 kg of flavoured, UHT milk and yoghurt, respectively.

Table 34: Monthly sales of dairy products from formal shops (Kg)

Places	Super-markets			Mini-markets			Other shops		
Products	Av.	SD	Total	Av.	SD	Total	Av.	SD	Total
Powder	43.41	103.70	3125.4	26.69	29.8	507.2	28.5	4.08	114.00
UHT	9.00	6.00	248.2	4.76	11.23	90.5	3.45	15.71	36.00
Concentrated	54.17	155.05	3900.2	8.92	20.26	169.5	16.8	19.41	67.20
Flavoured	37.5	75.00	479.4	6.66	21.73	150.0	5.54	13.55	105.30
Yoghurt	36.25	57.06	145.00	1.97	6.93	61.6	0.86	3.26	37.4
Butter	0.01	0.12	1.00	-	-	-	-	-	-
Local milk	-	-	-	-	-	-	-	-	-

Av.= average; SD = Standard deviation. – = Zero quantity has been reported

Source: Milk marketing survey (2002)

Considering that these are the three main outlets for imported dairy products, Table 35 shows the market share of each. For the domestic dairy products, the so-called informal sector holds the totality of the market. For imported dairy products, the super-markets control more than 65% of the domestic market. Most importantly, super-markets dominate 100%, 94% and 83% of the butter, concentrated and powder milk markets, respectively. Although the available data was insufficient for analysing the factors affecting shares of market, it is obvious that the size of the different containers has played an important role in determining the share held by other shops than the super and mini-markets. The former are small-scale and hold fridges with only small storage capacity as compared to the latter.

Table 35: Market's shares of the three main outlets of imported dairy products (%)

Products	Super-markets	Mini-shops	Other shops
Powder	83.42	13.54	3.04
UHT	66.24	24.15	9.61
Concentrated	94.28	4.10	1.62
Flavoured	65.25	20.42	14.33
Yoghurt	59.43	25.24	15.33
Butter	100	0	0

Source: Milk marketing survey (2002)

VIII. Consumption patterns of milk and milk production

This section analyses the market opportunities for new participants in the dairy sector, based on the current potential demand for milk and milk products. The presence of a large number of dairy farmers or the availability of milk surplus in a location, though a necessary condition for small-scale dairy enterprise development, are not sufficient in themselves. The nature of traditional consumption habits of local and imported milk and milk products determines opportunities and constraints to the dairy sector. Milk consumption patterns can be addressed in different ways that are often complementary or equivalent. Given the dominance of "informal" markets in The Gambia, evidence suggests that milk consumption at both individual and household levels are important factors to account for in the assessment of the demand for milk.

8.1. Analysis of individuals' demand for dairy products

This analysis uses data from a survey of 200 individuals in the Greater Banjul Area (GBA) and the surroundings to determine the factors affecting consumption of milk and milk products. The social structure of the surveyed sample is as follows:

- Education level: 136 illiterates, 17 primary school, 45 secondary school and 2 tertiary;
- Sex composition: 86 males and 114 females;

One should be cautious in interpreting these results and relate the results to the context and objective of the survey. First, the survey was carried around markets (Serrekunda, Bakau, Talinding, Latrikunda and Brikama) and non-markets sites (Siffoe, Tanje, Tambour, Pirang and Gunjur). Amongst the objectives were the identification of possible socio-economic and cultural barriers to milk consumption and the analysis of the potential demand for milk and milk products.

The results indicate that milk and milk products are in high demand. Whether this increasing demand for dairy products is influenced by consumers' socio-economic characteristics is of interest for the development of products. No clear pattern is discernable in the relation between the individuals' socio-economic characteristics and their decision to consume (or not) milk and milk products, irrespective of the origin of the product (local or imported). More than 90% of the interviewed individuals consume dairy products, whether they are men or women, basic or highly educated. Only in the illiterate group, did 50% not consume dairy products; a situation that can be attributed to the lack of income. Therefore demand for dairy products does not appear to be segmented with respect to the education or sex variables.

Likewise, dairy products are consumed irrespective to the individuals' professional status. Less than 10% of the surveyed individuals have indicated that they do not consume milk and derived products. Nonetheless, the individuals' profession cannot explain the pattern of dairy consumption. Again there is no segmentation of demand with respect to individuals' professions.

The analysis of individuals' preferences for dairy products allows for examining the relationship between consumers' preferences and the types and origin of milk and milk products. As expected, all interviewed individuals preferred cows' milk. However, 2-2.5% of the sample indicated preference for goats' milk. This constitutes a small market segment to goats' milk, whose market is largely in the hands of women.

Individuals' preferences in relation to the form (kind) of milk and milk products, indicate that local fresh milk is the most preferred amongst products (35% of the sample). On the other hand, about 33% of the surveyed consumers indicated preference for sour milk over any other form of milk, while 11% preferred skimmed milk and 9% evaporated milk presented in tin cans. The latter two forms of milk are

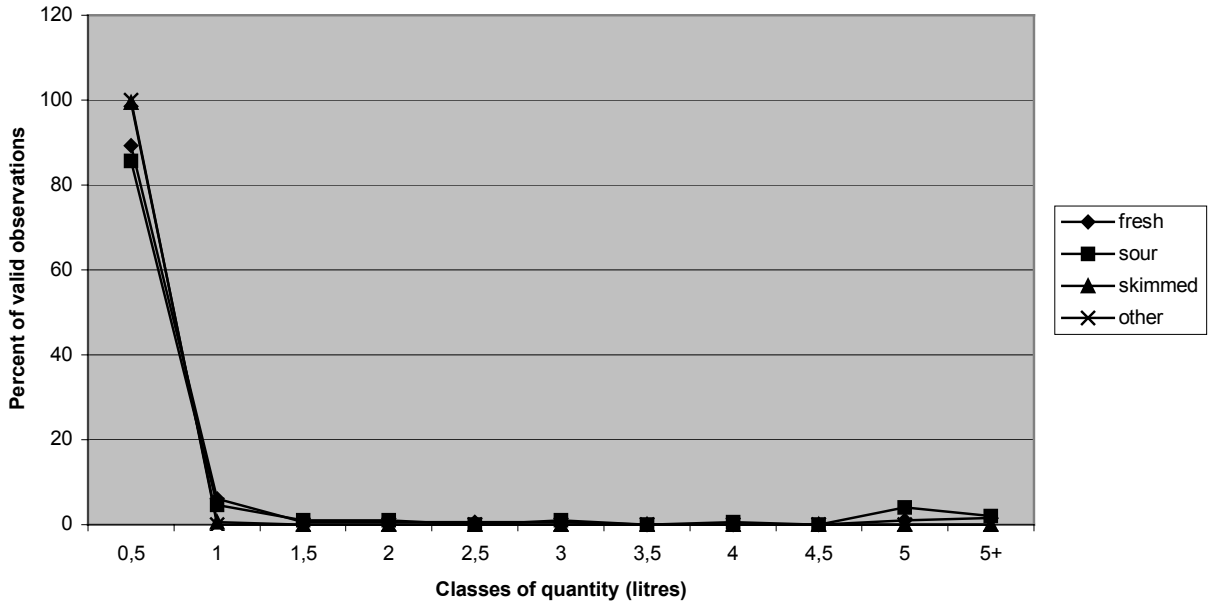
supplied through importation. There are some individuals who are indifferent between choices of fresh and sour milk (9%), or between fresh, skimmed and sour milk (4%). Since local fresh milk and sour milk are whole milk, one can conclude that this type of milk has high potential demand as compared to other forms.

The relationship between individuals' preferences and the origin of milk and milk products shows that 81% of the sample prefer local dairy products, while 18% prefer imported ones. On the other hand only 1% is indifferent between the choice of local and imported dairy products.

Despite the health risks associated with handling and processing of local milk, consumption of these products is still higher than that of imported products, known to be risk-free in most cases. Although it has not been possible to investigate the reasons for these preferences, some explanation can be attempted. First, the role of tradition should not be neglected as this often takes precedence over health concerns, independently of the level of individuals' resources.

Second, one should recognise that many resource-poor consumers simply may refuse to pay the extra cost that is associated with imported, processed milk, although this is assumed free of health risks. Since imported dairy products cannot easily be repackaged into small units for individuals' consumption at the price that most small

Figure 2: Quantity-based Strata of the demand for dairy products



consumers can afford, retail prices (when divisible) often deviate from any equilibrium prices. Consequently, individual consumers may only perceive imported dairy products as more expensive than local products.

The demand for dairy products should also be related to the ability for individuals to buy a certain amount of products, given a specified unit price. Figure 2 relates the quantity that individuals bought per day and the number of individuals who can afford to buy such quantity.

Because budget constraints precluded the collection of data on individuals' income, consumers were grouped into classes of milk quantities they could afford to buy. More than 80% of the individual consumers is concentrated in a segment of quantity of]0-0.5] litre, irrespective of the form of milk purchased. In other words, the majority of the interviewed individuals are only able to buy at most 0.5 litre of milk. This can be justified by the importance of consumption outside the household. For skimmed and other types of milk, the demand is curtailed. On the other hand, sour and fresh milk have a residual demand of over 1 litre, likely due to those individuals purchasing for household's consumption. The common aspect of the demand for dairy products, is the rapid drop from the class of]0-0.5] to the class of]0.5-1]. Thereafter, the decline is rather smooth followed by slight increase in sour and fresh milk demand or the demand is completely curtailed (skimmed and other milk).

8.2. Dairy product consumption by household and sources of procurements

The results of the household survey on consumption of dairy products, both imported and locally produced, are summarised in Table 36. Recall that 45 households were enumerated.

Table 36: Households monthly consumption of dairy products

Products	% HH consuming	Average (kg)	SD (kg)	Total (kg)
Imported milk and milk products				
Powder milk	57.78	9.39	23.94	244.28
UHT milk	4.44	4.8	4.53	9.6
Concentrated milk	44.44	4.77	7.59	95.49
Flavoured milk	2.22	6.4	0	6.4
Imported yoghurt	2.22	6	0	6
Butter	17.78	0.62	0.47	4.95
Local milk and milk products				
Fresh milk	37.78	13.02	10.94	221.28
Sour milk	55.56	9.58	10.96	239.53
Butter oil	17.78	0.67	1.39	5.34
Local yoghurt	4.44	7.5	6.36	15

SD= standard deviation.

Source: Estimation from household's survey (2002)

Among the imported dairy products, powder milk is consumed most frequently (58% of the sample) and in the highest quantities amongst all products (9 kg/month/household). Concentrated milk is consumed by 44% of the sample and represents the second most important product among the sample households. Yoghurt and flavoured milk are the least consumed (6 kg/month/household), and only 2% of sample households reported they consumed them.

For domestic milk and derived products, the most consumed is sour milk. Although its consumption averaged 10 kg/month as compared to fresh milk (13 kg/month), it is a widely consumed product (56% versus 38% for fresh milk). This explains why the total monthly consumption of sour milk (about 240 kg) is larger than that of fresh milk (about 221 kg). In general, even though households buy fresh milk, it is usually left to sour before consumption. The consumption of locally made yoghurt is slightly higher than the imported one, both in terms of the proportion of households (4%) and the quantity consumed on a monthly basis (8 kg/month).

Table 37 shows how frequently dairy products are consumed among the sample households. Overall, households' consumption of imported dairy products is occasional. However, 28.89% and 31.11% of the enumerated households reported daily consumption of powder and concentrated milk, respectively. Likewise, households' consumption of local milk products is rather more occasional than on a daily basis. Because of its scarcity and seasonality, only 28.89%, 8.89% and 4.44% of the sample reported a daily consumption of sour, fresh milk and local yoghurt respectively. It should be understood that the frequency of local milk products consumption depends on its availability. Since the survey took place during a period of availability, it is not surprising that some households have them in their daily meal. This result on the frequency of consumption constitutes an indication of the real existence of potential daily demand for local and imported milk and milk products.

Table 37: Frequency of household's consumption of dairy products in a month (% of HH)

Products	Daily	Occasionally	Products	Daily	Occasionally
Powder	28.89	28.89	Butter	0	17.78
UHT	0	4.44	Fresh	8.89	28.89
Concentrated	31.11	13.33	Sour	22.22	33.34
Flavoured	0	2.22	Butter oil	0	17.78
Yoghurt[1]	0	2.22	Yoghurt[2]	4.44	0

Notes: yoghurt[1] and yoghurt[2] represent imported and locally made, respectively.
Source: Estimation from households' survey (2002)

The analysis of sources of procurement for dairy products shows that households rely on various sources. For imported products, 81% of the sample procures powder milk from local shops, and 12% from super markets. The remaining buy in the mini-markets and in small-scale shops. All the households that reported consuming concentrated milk obtained it from local shops. In contrast with imported dairy products, places where households buy domestic milk products do not vary much. Almost all households buy both fresh and sour milk from informal places, such as markets, along the highway or from itinerant vendors.

An estimation of spatial price of domestic milk products shows that Brikama and Bijilo areas are the high prices locations, whereas Serrekunda offers lower prices (Table 38). Consequently, demand for domestic milk products is high in Serrekunda. The results of the survey indicate that whilst only 47% of the sample in Brikama area consumes at least one of the domestic milk products, they are consumed by 86% of the sample households in Serrekunda area.

Table 38: Spatial distribution of demand prices for domestic milk products (D/kg)

Locations	Fresh milk	Sour milk	Butter oil	Yoghurt	Pot. demand
Brikama	8	9.2	10.5	-	46.67
Bijilo	8	8	-	15	44.44
Sukuta	-	7.7	-	-	57.14
Serrekunda	5.8	4.5	5.6	-	85.71

Notes: - = no records; Pot. demand= potential demand as the percent of households that consume at least one of the domestic milk products.

Source: Estimation from households' survey (2002)

Overall, the demand of domestic products is relatively high, particularly in Serrekunda and Sukuta areas because of high population densities. Despite the small sample size, it can be seen that sour milk contributes largely to meeting the demand of these products, because it is surely consumed in all the surveyed locations. Fresh milk is second in importance.

8.3. Estimation of household demand function for domestic dairy products

Beside the average households' consumption of dairy products, it is important to know what factors affect the quantity being consumed. Moreover, in order to promote the dairy sector development, it is necessary to first identify the forces driving the demand. To achieve this objective, we used data from the households' survey (December, 2002). The survey covered 45 households in the GBA consuming a variety of dairy products. Given the limited number of observations, consumption was

aggregated per household, irrespective to the kind of milk, although distinction was made between imported and domestic products. Then, a weighted price was calculated for both groups. The following formula was used to estimate a simple demand function.

$$\log c = a + \alpha_p \log p + \alpha_i \log i + \alpha_d \log d + \alpha_m \log m + \varepsilon$$

Where *c* and *p* are the quantity and price of domestic milk consumed by household, respectively. The variables *i* and *d* represent the household's income and size, respectively; m is average purchasing price for imported milk and milk products (in milk equivalent). The parameters α_i are the elasticities with respect to each variable in the model, *ceteris paribus*.

As shown by the low adjusted R^2, the explanatory variables included in the model of the dairy demand have very low explanatory power of the variation of dairy products consumption by households. Many other variables would be needed to obtain an appropriate specification of the model for dairy products' consumption. A larger sample of consuming households would also increase the degrees of freedom and improved R^2. Since our objective is to analyse the income elasticity of demand, this simple model is however still helpful.

Table 39: Estimates of demand function for dairy products

	Imported dairy products		Domestic dairy products	
Variables	Coefficients	SE	Coefficients	SE
Lnmp	-0.026	0.389	-0.284	0.356
Lnlp	0.059	0.422	0.167	0.385
Lnhh	-0.757	0.551	0.778	0.503
Lninc	1.134	0.566*	0.566	0.517
Intercept	-5.763	3.806	-4.212	3.473
DW	2.052		1.65	
R2 adjusted	0.021		0.09	
Observations	42		42	

Notes: lnmp= log of weighted imported milk price; lnlp=log of weighted domestic milk price; lnhh= log of household's demographic; lninc= log of the estimated household head average monthly income; DW= Durbin Watson statistic for error autocorrelation. * 10% level of significance.

Source: estimation from households' survey (2002)

Three features of the demand for imported dairy products can be singled out. First, the signs of the coefficients for different variables are as expected and impact on the quantity of aggregate milk thus supporting economic theory, even if the effect is not statistically significant. Second, the income elasticity (1.134) is positive and statistically significant at 10% level. This means that an increase in the household head monthly income by 1% would increase the amount of milk consumed in the household by 1.13%. Third, the cross price elasticity suggests that an increase in domestic price affects positively household consumption of imported products. On the other hand, the direct price elasticity is negative meaning that an increase of imported products price decreases the amount consumed by the household. Both direct and cross price elasticities are not significant at the standards level of 1%, 5% and 10%.

The results of the domestic dairy products do not support (except Lninc's coefficient) economic theory, particularly with respect to expected signs. However, none of the variables included in the model is statistically significant at the standard probability levels. The value of the income elasticity here is 0.566, but not significant.

Whilst the parameter estimates could suffer from bias caused by excluded variables and the small sample size, the aggregating of different kinds of dairy products produced values that are not far from those found in the literature for developing countries. In Indonesia, for example, Oka and Rachman (1999) reported values of own price elasticities for milk ranging from –0.0.7 to –1.61; and income elasticities between 0.01 and 0.47. Winrock International (1986) report from various authors, has shown that income elasticities depend on the level of aggregation of the dependent variable. Thus, the income elasticity averaged 1.40 when using aggregate dairy products, 1.20 for fresh milk and 1.0 for powder milk. The income elasticity of aggregate demand for milk was estimated at 0.8, which varies from 0.5 for the Sahelian countries to 1.1 for Central Africa (Mbogoh, 1984).

IX. Conclusion

The results of this study show that smallholder milk-oriented farms operate in extensive and non-specialised production systems. In these systems crop and livestock are more or less integrated. Crop and livestock products contribute to food security and/or income generation for the farm households. However, smallholders are differently endowed in productive resources. This situation calls for reconsidering research-development approaches on smallholder farming systems, for the producers cannot be treated as homogenous.

The results indicate that smallholder's dairy farms have great potential because traditionally, farmers have always kept cattle and demand for milk in the rural community exists. However, the results suggest that a number of improvements need to be effected in order to raise the general productivity and viability in the smallholder dairy sector.

First, is the need to strengthen the milk production base through ensuring adequate feeding for the dairy animals throughout the production season. The results have shown that poor attention is given to cows' supplementation compared to draft animals. In addition, the potential of crop residues that could be available, is not yet well exploited. Only groundnut hay is of interest for farmers, the other crop residues being left out for free grazing by animals.

Second, the results indicate that animal health is an important constraint that needs intervention. This must include the improvement of the veterinary products delivery to farmers. The shortage of these products has been shown to seriously hamper improved disease control. Further studies should address the issue of veterinary product delivery systems, assessing the constraints and identifying possible solutions.

The study also established that milk marketing in the Kombo and Kanifing is overall profitable. However, a number of improvements need to be introduced to alleviate constraints encountered by sellers. Among the constraints listed by sellers are: transport facilities, inappropriate milk storage equipments, poor quality of milk and dairy products, and fluctuation in domestic milk supply. Transport appears

inadequate and affects milk quality and quantity supplied. This also increases unit transport costs, which impact the economic performance of milk marketing negatively.

The use of plastic containers (gallon) to store milk has a negative impact on milk quality and the storage duration. There is relationship between storage facilities and supply stability. Increased duration of milk storage could help to cope with supply instability. Improving the sellers' capacity for milk processing will solve many of these constraints. This would require the organisation of the structure of milk and milk products marketing in view of improving the efficiency. The results have shown the important role of collectors in reducing transport cost and increasing milk supply. These actors should be organised in an appropriate structure able to handle collection-transport at a low cost for sellers. The collectors and sellers need to be supported with adequate equipment.

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