Intensification and Competitiveness of Smallholder Dairy Production Systems in the Greater Nairobi Milk- Shed

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Résumé

Les systèmes productifs laitiers au Kenya sont très diversifiés en termes de races de bétail élevé, d'intensité d'utilisation des intrants (particulièrement la terre et le travail) et des systèmes d'alimentation du bétail. La libéralisation du secteur laitier de 1992 a encouragé la production de lait en permettant aux coopératives laitières et à des laiteries privées de jouer un rôle plus important dans la commercialisation des produits laitiers. Des changements dans les systèmes de production et de commercialisation sont donc attendus mais n'ont pas été documentés jusqu'à présent. Une étude menée conjointement par KARI (Kenyan Agricultural Research Institute), le Ministère Kenyan de l'Agriculture et l'ILRI (International Livestock Research Institute) a pour objectif de caractériser les systèmes de production laitiers dans le bassin de collecte de Nairobi afin d'identifier les contraintes et les opportunités de développement de ce secteur. Une enquête a été menée pendant les mois de mars et avril 1998 sur un échantillon aléatoire de 1389 ménages dans huit districts du Kenya. Cette première caractérisation des systèmes laitiers après la libéralisation met en évidence la forte variabilité des stratégies de production présentes dans les zones couvertes par l'enquête ainsi que la compétitivité croissante des systèmes de production moins intensifs. Une autre particularité de l'étude est l'utilisation conjointe du système d'analyse géographique (Geographical Information System) et de données collectées au niveau de l'exploitation. Ainsi des cartes représentant différentes mesures d'intensification de la production laitière permettent de visualiser la répartition géographique des différents systèmes de production. Un indicateur synthétique d'intensification a également été construit : la quantité de lait produit par unité de terre. Cet indicateur est ensuite comparé à des indicateurs du niveau de compétitivité au niveau de l'exploitation, le cash-flow net et le rendement du travail familial. Les données montrent que la relation entre intensification et compétitivité n'est pas simple puisque au niveau de l'exploitation et par vache, les systèmes les plus intensifs ont les niveaux les plus élevés de cash-flow et de rendement du travail familial, alors que par quantité de lait produit, ce sont les systèmes les moins intensifs qui apparaissent les plus compétitifs.

1. Introduction

Smallholder dairy farmers produce approximately 56% of the total milk production in Kenya and 80% of the total marketed milk (Peeler and Omore, 1997). Milk production systems vary widely, however, differing in the breeds of animals

reared, intensity of land and labour use, and feeding systems. The 1992 milk market liberalisation gave impetus for the increased offtake of milk, by improving opportunities for dairy co-operatives and private entrepreneurs to market dairy products. As a result, changes are apparent in production and marketing in the greater Nairobi milkshed. Yet little is known about these patterns of change and the effects of various determinants on them. A collaborative study by KARI/MoA/ILRI was undertaken to conduct the first systematic characterisation of the Nairobi milkshed, with a view to identifying constraints and opportunities for further development.

The characterisation of livestock production systems typically focuses on specific representative locations, thus compromising the validity of extrapolating the results, or it takes a broad view, thus compromising the detail of the results. By surveying randomly-selected households within areas stratified by land use zones, and by applying a combination of GIS-based spatial analysis techniques and statistical methods, this study provides detailed system and farm-level analysis across a wide range of farm and livestock sub-systems within the Nairobi milk-shed. This first systematic characterisation describes the wide variability of production strategies present in a relatively small area, and the growing competitiveness of less-intensive dairy production. It also applies in the Kenya setting some of the new methods available through linking GIS-based and farm-based analyses.

2. Survey design and implementation

A diagnostic survey to characterise the smallholder dairy households was conducted in the Central, Eastern and Rift Valley provinces of Kenya by the collaborative KARI/Ministry of Agriculture/ILRI team in March-April 1998 (Staal et al., 1998). This was done to compliment the earlier one done in Kiambu District in 1996. A total of 1389 households were surveyed in eight districts that represent a wide range of levels of dairy productivity potential and market access within the Nairobi milk-shed. Map 1 shows the districts chosen to carry out the survey in 1998, namely Narok, Nairobi, Maragua, Murang'a, Nakuru, Nyandarua, Kirinyaga and Machakos.

A stratified sampling method was used to select the sublocations (smallest administrative units in Kenya) to be surveyed. Based on the agro-ecological zones described by Jaetzold and Schmidt (1983) and field knowledge, six major land use systems, namely coffee/dairy, horticulture/dairy, tea/dairy, sheep/dairy, wheat/dairy and Nairobi were identified in the eight districts. Three population density classes were identified: less than 200 inhabitants per Km^2, between 200 and 500, and more than 500 (C.B.S, 1994). A total of twelve stratification groups were considered for the sampling design.

The sampling method is a multistage sampling, in which the first stage units are the sublocations and the second ones are the households. The number of

households to be surveyed in each sublocation is determined as a proportion of the total number of households in the corresponding sublocation, as given by the 1989 census figures (C.B.S., 1994).

Survey maps for each of the eighty-two sublocations were created from ILRI geographical information systems (GIS) databases, using ArcInfo software. The survey enumerators, who had previously been trained in the use of the survey instrument, visited their assigned sublocations and marked on the map the main landmarks (any permanent feature like a trading centre, a school, or a church). Two (or three) pairs of landmarks were then selected at random for each sublocation and line transects were drawn joining each pair. Sampling was thereafter done following as closely as possible the marked transects. Every fifth household on the left and on the right was interviewed alternately, regardless of whether they were agricultural or kept dairy animals. In this way, a random sample of all sublocation households was obtained.
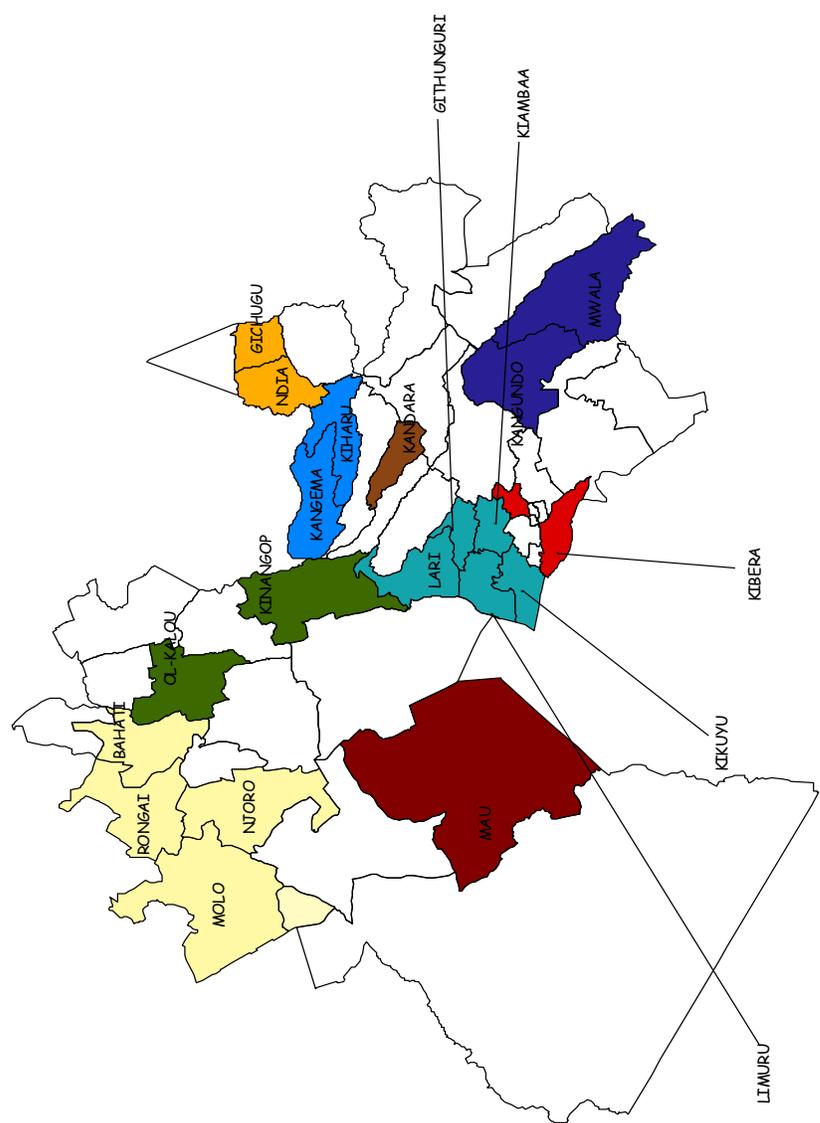
The questionnaires were completed through interviews with the household head or in his/her absence, the most senior member available or the household member responsible for the farm. Enumerators were asked to make appointments if this person was not available. Enumerators were selected among the front-line and supervisory extension staff of the Ministry of Agriculture in each district. A supervisor checked each completed questionnaire in order to get as accurate information as possible. The data from the questionnaires were entered into EpiInfo data management software and checked for data entry errors. Descriptive statistical analyses were carried out using Stata software.

The questionnaire is divided into sections covering: household composition, labour availability and use; farm activities and facilities; livestock inventory; cattle feeding distinguishing between on-farm feed and purchased feeding; dairying with emphasis on milk production and milk marketing; livestock management and health services; household income and sources; and co-operative membership, co-operative services and milk consumption.

Districts
- Nakuru
- Kirinyaga
- Kiambu
- Maragwa
- Murang'a
- Machakos
- Nairobi
- Nyandarua
- Narok

N

Map 1 : Surveyed Districts and Divisions in Kenya

100 0 100

100Kilometres

GICHUGU
NDIA
KANGEMA
KITHABU
KANDARA
GITHUNGURI
KIAMBAA
KINANGOP
OL-KALOU
BAHATI
RONGAI
NJORO
MOLO
LARI
MWALA
KANGUNDO
MAU
KIBERA
KIKUYU
LIMURU

3. Intensification level in dairy farming: indicators and relationship with farm land size

The results show that a majority of the surveyed households have agricultural activities (74.8% of the surveyed households) and more than three quarters practice dairy farming (75.3% of the agricultural households). Comparing the present situation with the situation prevailing ten years ago (the reference period used in the questionnaire), it can be seen that there is an increasing shift towards intensification of dairying through growing of fodder crops with "cut-and-carry" feeding systems and keeping of improved dairy breeds on the ever decreasing land available for agriculture.

The results presented in this paper include data from the eight districts described in section 2 and from Kiambu district, where the pilot survey was carried out in 1996. A total of 365 households were surveyed of which 340 (93%) had agricultural activities. The questionnaire has been slightly modified and some variables are not identical. When interpreting the results, it is worth keeping in mind that the Kiambu results reflect the situation prevailing two years before the other districts. However, data on prices have been updated and are these of 1998[1].

The data are analysed at the division level by aggregating household data at the division level in order to be able to represent graphically the results. The average milk production varies widely between divisions, from 3.13 litres in Kangundo (Machakos district) to 22.44 litres in Kasarani (Nairobi district) and between households. The level of intensification in dairy farming is analysed by computing the division average milk production per household per unit of land. Map 2 shows the geographical distribution of the variable (categorised by quartiles). Highly intensified areas are mainly situated next to Nairobi (whose position is given by the red dot) while the less intensified divisions are Narok in Masaailand (bottom left) and Machakos (bottom right). It is worth noticing that Njoro and Bahati (top left) exhibit a high density of milk production. These two areas are located in Nakuru district where land sizes are relatively small as it can be seen on map 3. The relationship between the level of intensification and land sizes will be analysed more deeply at the end of this section.

Other indicators of intensification reveal these geographical patterns. These are the main system for keeping cattle, the main breed reared on smallholder farms and the percentage of income from sale of animals in total dairy income.

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[1] Data on prices were collected on a weekly basis in 1998 during the longitudinal monitoring survey covering 21 farmers in four divisions of Kiambu district.
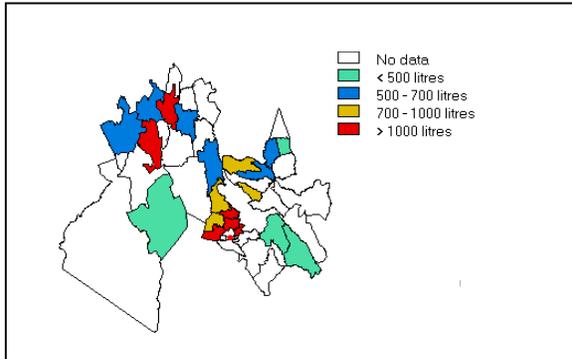
Map 2: level of intensification in dairy farming
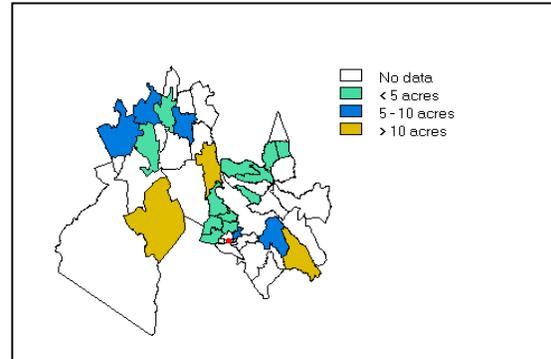
Map 3: land size (acre)

The main system for keeping cattle is defined as the most used system of rearing cattle in the division. Results show that the most practised system in the surveyed area is "only stall feeding" (12 over the 20 divisions), then "grazing" and ranking last "mainly grazing with some stall feeding" or semi-zero grazing. The semi-zero grazing system is paddock grazing on improved pastures with a little "cut-and-carry" or enclosing of animals in semi-permanent structures with predominantly "cut-and-carry" with little grazing. Areas where stall feeding is dominant are the ones close to Nairobi (southern divisions of Kiambu and Kasarani), Bahati division and Murang'a, Maragua and Kirinyaga districts (map 4).

The distribution of the main breed follows closely the geographical pattern of the feeding system, as map 5 shows. In fact, areas where improved cattle (cross bred and high grade cattle) are dominant are those where the majority of the farmers adopted the "zero- grazing" technology. On the contrary, local animals are found in grazing areas.

The third indicator is the percentage of income from sales of animals in the total dairy income (defined as the sum of the milk sales income and income from sales of animals). As it can be seen on map 6, Narok farmers get more than half of their dairy income by selling animals. On the other hand, for the farmers next to Nairobi, animals' sales constitute less than one sixth of the income from dairy activities, thus showing that they are more milk- market oriented.
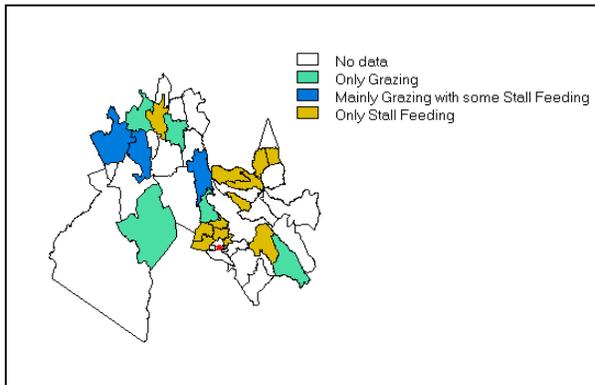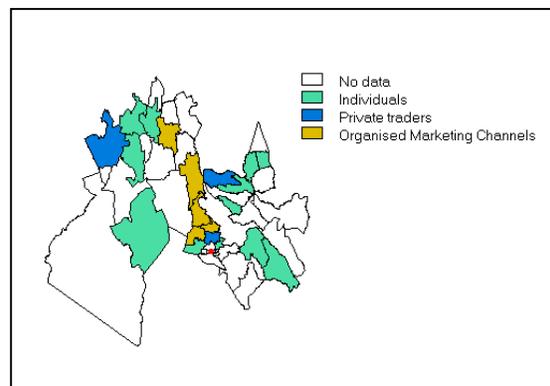
Map 4: cattle keeping system
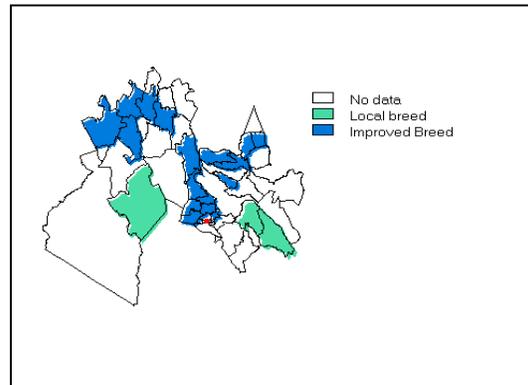
Map 5: dominant breed
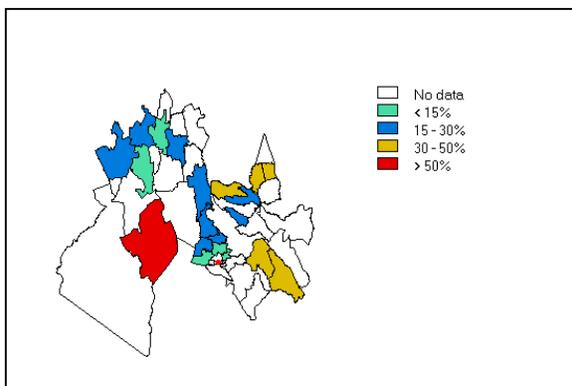
Map 6: percentage of cash from sale of animals in total dairy income

Map 7: main milk marketing outlets

The size of land holding per household varies greatly, and is generally seen as one of the main determinants of the intensification level. In the districts where land sizes are small and land is thus a primary constraint to production, farmers have an incentive to intensify. It is thus likely that in those areas farmers adopt an intensive system of keeping cattle, stall feeding as opposed to grazing. Kiambu and Kasarani are good examples of this pattern. Table 1 shows that the difference in land sizes is statistically different between systems of keeping cattle: households with more (less) land are more likely to adopt a less (more) intensified system. Comparisons of maps 4, 5 and 6 with map 3 also support this relationship.

Table 1: Mean land size per household by system of keeping cattle

System of keeping cattle	Number of households	Land size (mean)	Statistical difference at 5%
Grazing (1)	171	12.17	Yes with systems 3 and 4
Mainly grazing (2)	193	10.98	Yes with systems 3 and 4
Stall feeding (3)	262	3.57	Yes with systems 1and 2

Mainly stall feeding (4)	75	4.13	Yes with systems 1 and 2

The main marketing channels are also studied and are presented on map 7. The different outlets are categorised into three main channels: individuals, private traders and organised channels. Individuals include individual customers, hotels and restaurants while organised marketing channels include private dairy processors, parastatal collection point, co-operative collection point and farmer group. In 12 of the 20 divisions, the main outlet is individual consumers, hotels and restaurants. At the household level, milk sales are through individuals for 42%, then traders 22%, dairy co-operative societies and groups 12%, hotels and shops 12% and private processors and Kenya Co-operative Creameries each 6%.

The areas where farmers sell mainly to an organised channel are the northern divisions of Kiambu where co-operatives are well functioning (particularly in Limuru) and Nyandarua, where the Kenya Co-operative Creameries, previous to 1992 the sole authorised processor, is still a relatively important buyer as well as some processors and co-operatives. On the other hand, there are some divisions where private traders are dominant and these are Molo (Nakuru), Kangema (Murang'a) and Kiambaa (Kiambu). The first two are in areas quite far removed from urban consumption areas, where more organised milk collection schemes have not emerged. As a consequence, although this area is thought to be part of the milkshed supplying Nairobi, the observed importance of direct sales by producers to local consumers shows that much of the milk remains within this relatively highly populated production area.

4. Competitiveness and level of intensification

In order to assess the link between the level of intensification and competitiveness in dairy farming, two indicators were calculated. The first is the net cash flow derived from dairy activities; the second indicator is the return to family labour from dairying.

Net cash flows are calculated as the sum of the income from milk sales and from sales of animals minus the cost of hired labour, feed expenditures, health services and purchases of animals. Because labourers do not work exclusively on dairying, only a portion of the total cost of hiring external labourers (corresponding to the proportion of hours spent working on dairy activities in the total number of working hours) is taken into account in the calculation of the cash flows. Note that for Kiambu district, the cost of hired labour and the cost of health services were not available and as a consequence these two costs could not be included. Net cash flows are calculated by household, per cow (net cash flows divided by the number of cows) and per ton of milk produced (net cash flows divided by the annual milk production).

The second indicator is the return to family labour from dairy activities. This indicator takes into account the opportunity value of the milk consumed by the household and the opportunity cost of the feed produced on-farm. More precisely, the returns to family labour are computed as the cash flows calculated previously augmented by the market value of the milk consumed minus the rental value of land planted in fodder and pasture. Returns are calculated per farm, per cow and per ton of milk produced, in the same way as the net cash flows.

When analysing the data at the division- level, it can be seen (maps not presented) that the less-intensified districts have relatively high levels of cash flows (Narok and Machakos) while some areas that are highly intensified (Kiambu divisions) experience a rather low level of cash flows. However, given the high variability in the farmers' levels of competitiveness, it is important to conduct the analysis at the household level. Tables 2 and 3 present the mean cash flows and returns to family labour per farm by level of intensification.

Table 2: Net cash flows per farm, by level of intensification

Level of Intensification	Number of households	Average net cash flows	Statistical difference at 10%
Low (1)	114	37 337	None
Intermediate low (2)	141	36 239	None
Intermediate high (3)	170	41 454	None
High (4)	183	48 808	None

Table 3: Returns to labour per farm, by level of intensification

Level of Intensification	Number of households	Average returns	Statistical difference at 5%
Low (1)	108	32 875	(1) < (3) and (1) < (4)
Intermediate low (2)	132	44 629	None
Intermediate high (3)	158	53 741	(3) > (1)
High (4)	174	57 650	(4) > (1)

The cash flow results show a generally clear relationship with the level of intensification (Table 2), with cash flow increasing with intensification. None of these differences, however, are statistically significant. On the other hand, returns to labour per farm are clearly and significantly positively related to level of intensification (Table 3). This shows that, at current levels of prices and values for land, intensive dairying offers the highest returns to a household unit. However, this does not recognise differences in the opportunity cost of family labour between these areas, as those opportunity costs are likely to be considerably higher in high intensity areas. A more clear indication of level of competitiveness may be available from calculating these results per ton of milk produced (Tables 4 and 5).

Table 4: Net cash flow per ton of milk produced, by level of intensification

Level of Intensification	Number of households	Average net cash flows per ton of milk produced	Statistical difference at 10%
Low (1)	114	20 562	(1) > (2) and (1) > (4)
Intermediate low (2)	141	14 279	(2) < (1)
Intermediate high (3)	170	15 219	None
High (4)	183	9 679	(4) < (1)

Table 5: Returns to labour per ton of milk produced, by level of intensification

Level of Intensification	Number of households	Average returns per ton of milk produced	Statistical difference at 10%
Low (1)	108	24 140	(1) > (4)
Intermediate low (2)	132	18 733	(2) > (4)
Intermediate high (3)	158	19 801	(3) > (4)
High (4)	174	12 280	(4) < (1), (4) < (2) and (4) < (3)

The per ton results show that more intensified farms earn on average lower returns to labour than less intensified farms per quantity of milk produced. Although at the farm level and per animal, farmers with intensified rearing systems are better off, per unit of milk produced less intensified systems are more competitive. These results suggest that if milk prices fall, low intensity systems will remain competitive, while high intensity dairy production may not. Own-farm feeding and use of pasture when land is available may thus be an economical way to produce milk, and high intensity zero-grazing cannot be viewed as the only means to increase milk production in Kenya, in spite of the emphasis on that approach by many dairy development efforts. The use of higher levels of external inputs (labour, feeding, veterinary services and extension services) characteristic of high intensity dairying is not economical in areas where poor market access and lack of organised marketing channels result in low milk prices.

5. Conclusions

The survey conducted in eight districts in Kenya shows how the production systems are different even in the relatively small area surveyed. They differ in terms of level of intensification, market access and level of competitiveness. More intensified systems are found mainly in the divisions close to Nairobi where high milk prices act as an incentive to produce more as well as in the divisions where land (rather than labour) is a limiting factor due to the population pressure. Nevertheless there is no clear-cut relationship between the intensification level and the level of competitiveness at the farm level. Per farm and per cow, more intensified systems show higher levels of net cash flows and returns to family labour, while per quantity of milk produced less intensive systems appear to be more competitive.

Production systems in dairy farming in Kenya thus display a wide variability of strategies, each of it responding to the particular marketing and environmental conditions present in the area. The longer term competitiveness of these systems, therefore, depends not only on the direction in which labour and land values change over time, but also on changes in market and institutional infrastructure. The results show that organised marketing channels are still mainly predominant in areas closer to the Nairobi milk shed, while in more distant areas, direct sales to consumers and traders prevail. If road and market infrastructures improve over time, organised marketing is likely to better reach distant areas, enabling high milk prices to those producers. Under those circumstances, the competitiveness of production is likely to shift significantly.

Acknowledgments

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