Can raising goats for milk be a viable opportunity for small crop-livestock integrated farms in Nile Delta, Egypt?

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Summary

Background: Egypt, the third most populous country in Africa, has intense land fragmentation in the Nile Delta, where the size of most farms is under half a hectare. Agriculture, which employs 30% of the population, is facing challenges from water scarcity and declining soil fertility. Large ruminants are harder to maintain due to rising feed costs, worsened by the 2016 devaluation and the ongoing Ukraine-Russia war. ***Aim***: This study explored diversification strategies in small farms in the Nile Delta (Behera governorate), focusing on small ruminants as a potential economic alternative. ***Methods***: The present study analyzed farming systems using the agrarian approach, gathering data through landscape observations and farmer interviews in 2023. A technical-economic analysis evaluated farm performance, and proposed exploring the economic benefits of integrating Egyptian Nubian (Zaraibi) goats. Four breeding scenarios to improve income were assessed, focusing on the type of reproduction and the prices of goat milk. ***Results***: Introducing Egyptian Nubian goats could boost farm income by 28-54%, but high inflation, access to feed, and limited grazing land pose challenges. ***Conclusions***: Improved crop residue utilization, veterinary care, and organized goat breeding are crucial. The goat milk market is currently underdeveloped, and farmers must collaborate to process and market their production effectively. Improved water management and access to credit are also essential for farm sustainability.

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■ INTRODUCTION

Egypt, which had 104 million inhabitants in 2021, is the third most populous country in Africa. The population is primarily rural (57%), and experienced a growth rate of 1.7% between 2020 and 2021. Each year, 800,000 young people enter the labour market. The Sahara Desert spans a large part of the country, and the population is mainly concentrated along the edges of the Nile Valley and Delta. This area, which is known for its intensive irrigated agriculture, covers only 4% of the country's total territory (Ministry of Agriculture, 2023). The agriculture sector, which employs around 30% of the working population and accounts for almost 12% of the Gross Domestic Product (GDP), is based on irrigated crops, with most of the water coming from the Nile (85%). High demographic pressure in the deltaic regions, combined with the inheritance practices implemented since the 1952 agrarian reforms, has resulted in significant land fragmentation. As a result, most farms are now smaller than one feddan (the equivalent of 0.42 ha) in size, and some are even as small as half a feddan (0.21 ha) (Acloque, 2019). In the Nile Delta, there is a differentiation between old and new reclaimed land. The old lands are lands "gradually cultivated since Antiquity thanks to the control of the Nile flood and land reclaimed from marshland at the turn of the 20th century" (Acloque, 2019). Long established agricultural lands in the Nile Delta are experiencing a reduction in irrigation water from the Nile, as well as a decline in soil fertility. This is due to the alluvial deposits from the Nile being largely obstructed by the High Dam, resulting in only minimal quantities reaching the northern parts of the Delta (Wahel, 2018). The high land pressure has led to the development of diversified production systems based mainly on cereal and fodder crops, which provide food and feed for families and their animals

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(dairy cows and buffaloes, as well as small flocks of sheep and goats). Cash crops also are often cultivated next to cereal and fodder crops.

Despite the importance of livestock in the Delta's production systems, the land pressure makes it increasingly difficult to maintain large ruminants, buffalo or cattle, due to their high feed requirements. Moreover, the devaluation of the Egyptian pound (EGP) in 2016 and the increase in inflation between 2022 and 2023 (almost 40% in August 2023) (Le Monde Afrique, 2023), have dramatically affected market cereal prices. Raising large ruminants has become economically risky. In this context, farmers are obliged to find new ways of maintaining (or even improving) their living conditions, notably by exploring the potential for diversifying their sources of income through sheep and goats, which require less feedstuffs than large ruminants (cattle or buffalo). Traditionally, sheep and goats are mainly raised to sell young animals, providing a source of cash flow for the family, and goat milk is mostly used for family consumption. In the present study, we aim to explore whether the marketing of goat milk products could contribute to income diversification.

According to Reardon *et al*. (2006) and Asfaw *et al*. (2019), diversification pathways depend on internal factors at the family farm level, i.e., their socio-economic conditions, and on external factors embedded in the environmental and institutional context within which they operate. Diversification of both on-farm and off-farm activities is often analyzed as a response to a lack of alternatives for coping with the effects of shocks, such as extreme weather events, crop diseases, and unexpected price increases (Bandyopadhyay & Skoufias, 2013), or as a means to manage the uncertainty of agricultural production, as illustrated by Ellis (2005). In the context of land fragmentation in the West desert oasis, Alary *et al*. (2016) showed that raising sheep and goats constitutes a cost-effective option when the area of cultivated land is too small to feed large ruminants.

Consequently, understanding the potential effects of push versus pull factors on the households' allocation of capital, labour, and land is crucial for exploring different potential diversification strategies. The agrarian approach formalized by Cochet (2011) is useful for this, as it allows the exploration of land, labour, and capital at the farm and regional scales over time, taking into account changes in the accessibility and development of agricultural infrastructure, including market and information access.

The present paper proposes to use this agrarian approach to characterize the production systems around the villages of Sabaïn and Khamara, located in the governorate of Behera in the northwest area of the Nile Delta. Our main question concerns whether raising goats to produce milk for sale could be a viable diversification option for small integrated crop-livestock farms in the Nile Delta region of Egypt.

The main hypotheses were as follows: (i) Given the various social, economic, and bioclimatic constraints, small ruminant farming in the Delta could help to reduce the vulnerability of the poorest families; (ii) With land becoming increasingly fragmented, goat farms could make good use of small areas of berseem (Egyptian clover), which is essential for crop rotation; and (iii) Under certain conditions, the development of goat farming for milk production could enable certain families to diversify and improve their income.

■ MATERIAL AND METHODS

Data collection

The study area is located west of the Nile Delta, in the old lands of the Behera governorate, close to Itay El Barud (Figure 1). This research covered an area of approximately 90 km^2 around the villages of Sabaïn and Khamara.

This paper is part of a more complete agrarian diagnosis study conducted as part of an end-of-study thesis. Data collection was carried out at the household, intermediary, and consumer levels with the aim of studying the development potential along the entire value chain.

First, at the household level, various tools were used to meet several objectives. To understand the biophysical environment, the organization of the farming systems, and their evolution over the past few decades, with a special focus on livestock dynamics, we used different approaches, including observations, focus groups, and a farm survey with the inhabitants at the landscape level. This involved analysing satellite images (Map data 2015 Google and 2023 Google) and

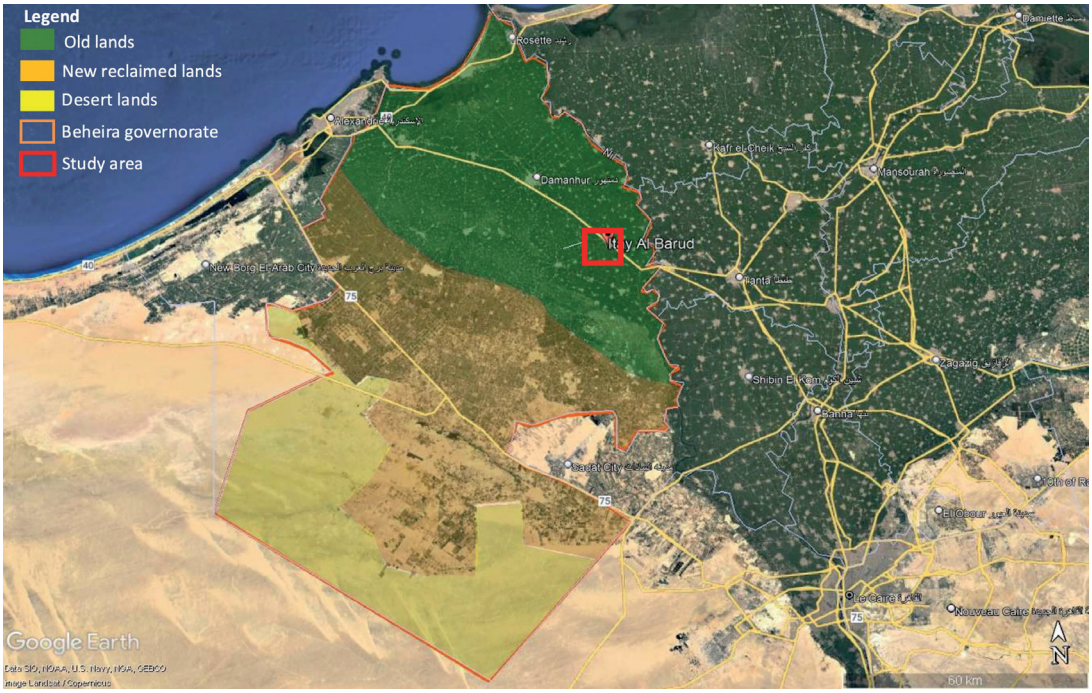

Figure 1: The Behera Governorate in the Nile Delta, a territory with three major soil-climate and agricultural zones /// *Le gouvernorat de Behera dans le delta du Nil, un territoire composé de trois grandes zones pédoclimatiques et agricoles*
Source: Google Earth, Hautbout, 2023

bibliographical resources, structural and functional observations of the landscape, and the organization of two focus groups. The first focus group consisted of four male farmers from Sabaïn, while the second included five male farmers from Khamara, all aged between 40 and 75. The purpose of these focus groups was to obtain precise information on the history and evolution of the cultivated ecosystems and production systems. The farmers were chosen by a local guide who had good knowledge of the farmers in the villages. The criteria given to the guide for selecting the farmers were their age (middle-aged to older individuals to obtain a historical view of agriculture) and the diversity of their socio-economic profiles. Most of the farmers were male due to women having little access to land. This phase of the study allowed the establishment of a typology of production systems based on landscape observations, a review of the literature, and "farmers' sayings" during focus groups. Working from this preliminary typology, which was composed of five types based mainly on land tenure and access, complemented by off-farm work, family composition, farm equipment, and crop and livestock systems, purposive sampling was done to "*study each category of farm identified without any of them being penalized a priori by their low representativeness*" (Ferraton & Touzard, 2009).

Based on this pre-typology, we selected a sample of farmers from the study area, with the aim of finding at least three farmers in each defined type. To do this, we first relied on our guide's knowledge of local farmers, and then met some farmers by "word of mouth." This step involved conducting two successive semi-directive interviews: the first aimed to characterize the farming systems, while the second took a more sociological approach, exploring current and future perceptions of the place and role of the different livestock activities at the farm and landscape level. For the first series of interviews, we conducted approximately 15 semi-structured interviews using a questionnaire to assess the technical and economic characteristics of crop and livestock farming activities and their management at the farming household level. The questionnaire was structured around seven modules that covered the farmer's and family's background, the history of the farm, the evolution of the landscape and production systems, the farm's land, crops, and livestock type and management with a focus on goat farming, and the farmer's perspectives. For the second series of interviews, we conducted 22 semi-directive interviews using a sociological approach with both the same farmers interviewed earlier and some new ones. The questionnaire was structured around six modules covering the role of different types of animals in the family, advantages and disadvantages of sheep and goats, perception of an increasing number of goats and diversifying into goat milk production, traditional milk processing, perception of goat milk processing, and collective actions in the village.

Secondly, at the intermediary level, to explore the potential for processing and marketing goat milk and meat, we conducted 20 semi-directive interviews with cow/buffalo milk collectors, factories, and traders in and outside the study area. The preliminary study of the literature and previous surveys enabled us to identify different types of factories (artisanal, semi-industrial, industrial) and collectors (small and large). Actors of each type were identified in the study area, and between Alexandria and Cairo. We then interviewed the actors who accepted to be interviewed.

At the consumer level, the fieldwork was completed with an online survey of 57 people, mainly in Alexandria, to assess the consumption of bovine and caprine dairy products and how this consumption was evolving. The questionnaire was sent to the various social circles of people whom we met in Alexandria during the months of fieldwork. This survey was structured around six modules addressing consumer characteristics, dairy product consumption habits, trends in dairy product consumption, household spending on dairy products, consumption of goat and sheep milk products, and sheep and goat meat consumption.

Economic analysis

We conducted the economic analyses of the previously identified production system types using a technical-economic approach that was based on the actual data collected during the interviews.

The comparison of the economic results of the production systems studied was based on the use of three main indicators: Gross Value Added (GVA), Net Value Added (NVA), and Farm Income (FI). The GVA gives an overview of the wealth generated by each farming system's different crop and livestock systems at the household level. The GVA was estimated by subtracting intermediate consumption (IC) used in the crop and livestock activities (like animal feed, veterinarian costs, fertilizers, pesticides, diesel, etc.) from the total production, including sales and self-consumption for all products issued from the farm (milk, animals, manure, cereals, vegetables, etc.). The NVA, which measures the net wealth produced by the farmer, is calculated by considering the economic depreciation of the fixed capital (tools, pumps, carts, boreholes, etc.) needed to run the system (Ferraton & Touzard, 2009). Part of the net wealth produced by the farmer is taken by the rest of society (taxes, land rents, wages, etc.), and certain subsidies may be added. The FI is the remuneration of the family labour force invested in the production system. In the case of this study, it was calculated as follows:

FI = NVA – (workers' wages + taxes + land rents) + subsidies

All calculations are based on the current prices (farm gate prices given by farmers, and prices collected at local markets) at the time of the study (2023). For crops harvested in the summer of 2023 for which we did not yet have the selling prices, such as rice, a 40% inflation rate was applied to the price of the 2022 harvest (Ramadan, 2023).

Economic simulation of diversification with a dairy goat breeding

A technical-economic simulation also was conducted to explore the diversification towards mixed-breed goat rearing for one type of production system, namely small, diversified farms. The type was chosen based on the results of the technical-economic analysis, the assessment of the financial and technical resources available for diversifying their activities, and their interest in doing so. The absence of any references on the feeding and milk productivity of mixed-breed goats from which milk is collected led us to rely on the study by Abou-Elenin *et al*. (2016). They carried out an experiment involving over 30 Zaraibi female goats at the Sakha experimental station in the governorate of Kafr El-Shaikh, located in the north-central part of the delta, which has climatic conditions similar to our study area, and the goats were fed using local resources.

The Baladi goat breed, the most common in the area, has very low milk productivity. As mentioned by Galal *et al*. (2002), exotic breeds such as Saanen and Alpines are not very well adapted to the local climate and require special management conditions, which are expensive. This is why the Zaraibi goat breed was chosen for the simulation. In this experiment, we select the case of a feed system that records the best economic efficiencies and corresponding to milk productivity that can be found in several scientific documents: 1.14 kg of milk/day/head during the suckling period and 0.7 kg/day/head during the milking period (seven months). The fertility of these goats was 0.9 (Mourad, 1993), the average prolificacy was 1.8 (Galal *et al*., 2002), and the mortality rate was 10%. These performances were used in our simulation. Based on the breeders' available space and the availability of forage on the small farms in our study area, the simulation was carried out for five does per breeder.

Four scenarios were proposed depending on the type of reproduction, natural mating via a buck shared between several farmers or a buck of an agro-pastoral herd, and the selling price of goat milk defined on the basis of the current market, 43 or 71 EGP/kg. The sale of meat from fattened males, female kids, and culled goats was also included in the simulation. A fixed price was used, based on farm gate prices at the time of the study. For the economic calculations, the same methodology presented above was used.

■ RESULTS AND DISCUSSION

Characterization of the production systems in the area according to access to land and the variable role of goat rearing in these systems

Until 1952, the land was mainly in the hands of large landowners who farmed or leased the land to other farmers. At the time of Independence in 1922, 11,000 large landowners owned 70% of the land (Fanchette, 1997). In 1952, Nasser's agrarian reform limited land ownership to 50 feddans (21 ha) and redistributed plots ranging in size from 2 to 5 feddans (0.84 to 2.1 ha) (Ruf, 1995). Since then, population growth and the division of holdings through successive inheritances have led to a dwindling amount of land available to households for cultivation. This has led to the rapid growth of pluri-activity in the area.

As a result, the historical distribution of land in the old lands of the Nile Delta has led to a differentiation between farms over the past several decades. Based on this heterogeneity of access to land, which is at the root of differences in cropping and livestock production systems and of pluri-activity, five significant types of production systems were identified through the diagnostic exercise (Table I; Suppl.Mat I).

Type 1 - Landless families

In landless families (often linked to family history, such as divorced or widowed women), farming is always a complementary activity to another source of income. This activity is based on rearing sedentary small ruminants, either Rahmani ewes, Baladi goats, or both. In general, the total number of ewes or does not exceed three, as the available forage area is very limited. The families gain access to land by renting a few kirats (1 kirat = 175 m^2) in winter (varies according to the number of breeding females), and very often, a family member or neighbour lending them 1 or 2 kirats in summer. The main cropping system is based on berseem (*Trifolium Alexandrinum*) in winter and darawa (*Zea Mays L.*) in summer as green fodder. Apart from berseem and darawa, other feedstuffs are purchased. Some of the bran comes from the household's flour production, and dry bread from household waste. Depending on the time available, some farmers or their children go with the sheep and goats (never only the goats) to scavenge in and around the village. In this type of system, farmers do not have a male for mating. After the lambs and kids are weaned at four months, the breeding females are sent to a larger small ruminant breeder (as described below) for one or two weeks to be serviced.

While landless families may have kept a large dairy ruminant in the past, rising land rental and feed prices have forced them to sell it. Raising small ruminants is a way to supplement household income by selling lambs and kids, and provides a reserve of standing capital when needed. Farmers invest in dams when they have sufficient cash flow, and de-stock in the event of financial need (marriage, death, illness, etc.). In addition, some families sacrifice young animals during traditional festivals, indicating their important social role. However, the priority is often to sell the animals, which are consumed only if the family has no financial need.

Type 2 - Diversified micro-farms

The micro-farm families own less than half a feddan (eq. 12 kirats = 0.21 ha) and rent a few kirats to supplement their income. Some families with only 6 kirats (1050 m^2) and insufficient cash to rent additional land must buy animal feed to maintain a large dairy ruminant. In most cases, the land owned is the result of an inheritance division between several brothers, with each receiving a very small

Table I: Summary of the five major types of production system identified by the diagnosis /// *Synthèse des cinq grands types de systèmes de production identifiés par le diagnostic*

	Type 1	Type 2	Type 3	Type 4a	Type 4b
Name	Landless, rental of a few kirat for the winter	Micro-farm	Small farm	Medium-sized farm focused on crops and large ruminants	Medium-sized farm with agro-pastoral small ruminants livestock
Land area (feddans or kirat)	Renting or loan of few kirat in winter to crop berseem and in the summer to crop darawa	Ownership: 6-12 kirat (0.1 – 0.21 ha) Rental: 6-12 kirat (0.1 – 0.21 ha)	Ownership: 1 feddan (0.42 ha) Rental: 2 feddan (0.84 ha)	Ownership: 5 feddans (2.1 ha) Additional rental possible	Ownership: 5 feddans (2.1 ha) Additional rental possible
Off-farm work	Yes full-time	Yes part-time	Sometimes for occasional work	No	No
Family composition	1 family active worker	1 family active worker	1.5 family active worker	1.5 family active worker	3 family active workers
Crops	Winter: Berseem Summer: Darawa	Rotation based on main cereals (wheat, corn, rice) and forages (Berseem, darawa)	Rotation based on the main cereals and fodder, sometimes with the introduction of a high value-added cash crop (sesame).	Rotation based on the main cereals and fodder, and high value-added cash crops (pepper, sesame, cabbage etc.)	Rotation based on the main cereals and fodder, and high value-added cash crops (pepper, sesame, cabbage etc.)
Livestock	1-2 goats/ewes	1 dairy cow, 1 goat	2 dairy cows, 1 dairy buffalo, 2-3 goats/ewes	2 dairy cows, 1 dairy buffalo	2 dairy cows, 1 dairy buffalo, 45 ewes, 5-10 goats

area. The land is divided into several scattered plots which are farmed in a rotation based on cereals and fodder. Almost all crops (silage maize and grain maize, wheat, berseem, darawa) are used to feed one dairy cow, a goat or a sedentary sheep besides providing food for the family (rice, wheat). Crop management is predominantly a male activity, while day-to-day activities related to livestock farming are mainly carried out by women with the help of children, mainly girls. One family farm worker is mobilized (half-time for the woman and half-time for the man), and the man has a job as an agricultural or non-agricultural labourer in the area.

In contrast to the "landless" type, the micro-farms implement a diversification strategy that prioritizes the rearing of large dairy ruminants, which accounted for 63% of the total GVA in 2023 (Figure 2). For these families, keeping a cow is a priority because it represents food security through the supply of milk, and secondly provides a regular source of income through the sale of any milk surplus to collectors. A fattening calf represents a capital asset, providing a source of income when cash is needed. Rearing a goat or ewe is a complementary activity (12% of total wealth produced with only one goat (Figure 2)) in that it is easier to frequently stock and de-stock when needed (fast production cycle, higher prolificacy), the animals require little feed, and they valorise different feed resources (cut grass at the edge of fields, crop residues). Lambs and kids can also be consumed by the family or during religious occasions, which is essential given the sharp rise in meat prices. Both farming systems produce manure, used as an organic soil amendment.

Type 3 - Small diversified farms

When families own more than 1 feddan (0.42 ha), they tend to develop crops for both self-consumption and to feed their animals (corn, rice, darawa, wheat, berseem), and a crop solely for sale (sesame, for example). They combine several livestock systems, such as two Frisian and Baladi cross-bred dairy cows, one dairy buffalo, two goats and one ewe, as well as a donkey. To keep all these animals, one feddan (0.42 ha) is usually insufficient, and families rent pieces of land. On average, these families cultivate around 3 feddans (1.26 ha). The vast majority of families in type 3 are composed of brothers who have not divided their inheritance of land and still live together with their respective families, or families where the father is still alive and looks after the crops with the help of his sons in their spare time. More rarely, land may belong to a single man who inherited it as his part of his inheritance when several feddans were divided between brothers, or who managed to buy more land (with money from off-farm activities) to supplement the inherited land. This type also includes some landless families renting land or crop sharing for several generations. This tenancy has been passed down through the family, and despite the insecurity of land tenure, they have the same type of activity as diversified farms. On average, one full-time family worker works on crops and one part-time worker, often a woman, on livestock. For specific tasks, such as weeding or harvesting maize and sesame, relatives or neighbours help, and the farmer also hires casual labourers.

Small farms adopt a diversification strategy, but access to a larger area enables them to cultivate more crops and cash crops, which account for a larger share of the GVA compared to micro-farms: 44% of wealth is produced by crops (Figure 2). The buffalo's milk production is mainly processed into dairy products and consumed on the farm, so it is important for the family's food security. Surpluses can be sold on the local market. Conversely, cows provide daily income through the sale of milk, and occasional income through the sale of calves. Large ruminants are a source of standing savings that can be used for investments or to cope with economic shocks. Along with crops, large ruminants play a pivotal role on the farm (48% of GVA, Figure 2). As on micro-farms, the roles of does and ewes complement those of large ruminants (8% of GVA) through the financial flexibility they provide and their social and feed security roles.

Type 4a - Medium-sized farms focused on crops and large ruminants

Medium-sized farm families are most often able to buy land with the financial help of family members working off-farm or abroad. The family usually comprises brothers who still live together and share resources from different sources. With greater cash flow, farmers orient their activities towards more productive crops that require a high level of investment but offer a high GVA. The land is divided into several plots following rotations based on forage and cereal crops (maize, rice, darawa, wheat, berseem) for animal and human consumption and summer cash crops (pepper, sesame, cabbage and beans). Fodder and cereal crops are used to feed large dairy ruminants, whose number fluctuates according to the family's financial capacity and the land area used to cultivate crops for animal feed.

Compared to the previous types, the medium-sized farms concentrate their production on cash crops, representing 72% of GVA (Figure 2), while keeping large dairy ruminants. These animals are essential for adding value to berseem and crop by-products (wheat straw, rice straw, etc.), producing milk and manure, and providing daily income. More rarely, some families may keep a few small ruminants, but mainly for self-consumption. This strategy allows them to have only 1.5 family members working on the farm, supplemented by hiring

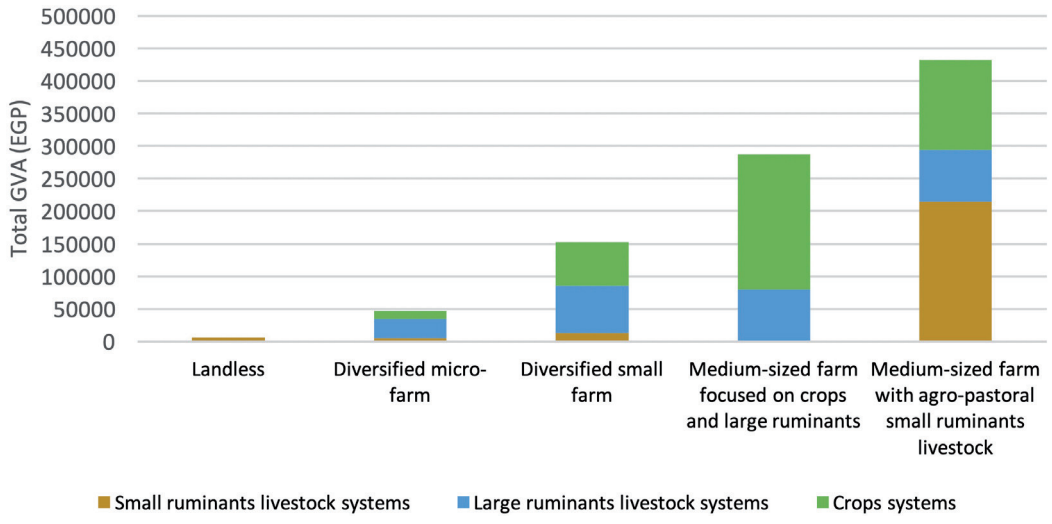

Figure 2: Share of farm activities (crop, large or small ruminants) in the total Gross Value Added for different production systems /// *Part des activités agricoles (cultures, grands ou petits ruminants) dans la valeur ajoutée brute totale pour différents systèmes de production*

casual labourers. In this way, the other family members can work outside the farm.

Type 4b - Medium-sized farms with agro-pastoral small ruminants

The "medium-sized farms" such as those described above may also be involved in small ruminant agro-pastoral farming. The flocks combine ewes, often of the Rahmani breed (between 40 and 70 ewes on average), with a few Baladi goats (between 5 and 10 does). The feeding system for small ruminants relies primarily on grazing crop residues (beans, wheat, berseem, corn, onions). Some ruminants also can move to the newly reclaimed lands to graze crop residues from cotton, watermelon, strawberries, etc. In winter, they graze berseem, and farmers buy berseem plots to graze. In summer, the herds feed on whole maize fields if the farmer has sufficient financial resources to buy the standing maize or owns his plot. Mating is carried out by the males from the herd, who remain continually with the females. In addition, they are rented by the breeders of the systems described above to ensure the reproduction of their herds. After weaning, breeders dry the ewes. When breeders have enough space at home, they fatten some young males based on their financial capacity.

Families of this subtype are usually united rather than divided by inheritance, and live and work together. Their land capital has been built over time by parents and grandparents who bought land by selling their animals. Adding a small ruminant livestock production unit requires 1.5 extra workers to look after the herd, so there are often three family workers working together to manage the farm.

Medium-sized farms that manage small ruminants obtain half of their GVA from sheep and goat activity (Figure 2). This activity has often been passed down from the father or grandfather. It was maintained when several sons agreed to take over the family farm, including one son to keep the herd, and when the land and capital were sufficient to feed the herd. Generally, sheep and goats constitute the family's primary source of income. However, they also provide capital to invest in other activities, such as buying land, building houses, etc. Some of the lambs and kids can also be slaughtered during traditional feasts. The goats, which are a small part of the herd, are kept in particular for family consumption and to suckle adopted lambs. Farmers prefer rearing ewes, because they are considered easier to manage and provide a better gross product. However, they note that goats are more resistant to heat stress in summer, and their meat is less fatty, which consumers appreciate. Finally, lambs are sold at a higher price than kids.

There are still a few large landowners in the area with dozens of feddan. They rent out a large proportion of their land and strongly influence rent prices and the land tenure security of farmers cultivating these lands.

The role of goat rearing within production systems thus varies from landless to medium-sized farms. Sedentary goats play a more important role in the production system when families have little or no land. Due to their low feed requirements, they can use small areas and feedstuffs that are not consumed by large ruminants, and can bring in financial resources thanks to their short production cycle. Large dairy ruminants, on the other hand, play a predominant role when families have enough land to feed them, i.e., from half a feddan (0.21 ha) onwards. Indeed, their daily production of milk, which can be consumed and sold, makes them a priority for families, thanks to a dense collection, processing, and marketing network. Therefore, even if they only have a small area of land, they try at all costs, by renting land or buying feed, to keep at least one large ruminant in the family.

Comparison of farmer incomes and interest in diversifying with dairy goats

After describing the different production systems, we will explore their potential for diversification with dairy goats as a function of income from agricultural activity, family socio-economic organization, access to land, and other sociological parameters.

Figure 3 shows farm income generated as a function of the area farmed by the different production systems. Farm income per family worker increases almost linearly with the land area farmed per worker.

The landless family – a type facing many constraints for developing dairy goat farming

The income per worker of landless families is only EGP 3,740 (Figure 3). They have a particular interest in continuing or even intensifying the rearing of small ruminants if they can, as rearing large ruminants is quasi-impossible for them due to high feed costs, not to mention the initial investment required to start the activity. Income from the small ruminant activity is usually used to cover daily or occasional expenses, and is rarely invested in expanding the herd. Therefore, these families expressed the need for access to credit or funds to buy animals and some of the feed, and to rent land to cultivate berseem and darawa. The space available in the home is also a constraint, as these families often live in small houses with no courtyard. When the man works full-time outside the farm, he has limited

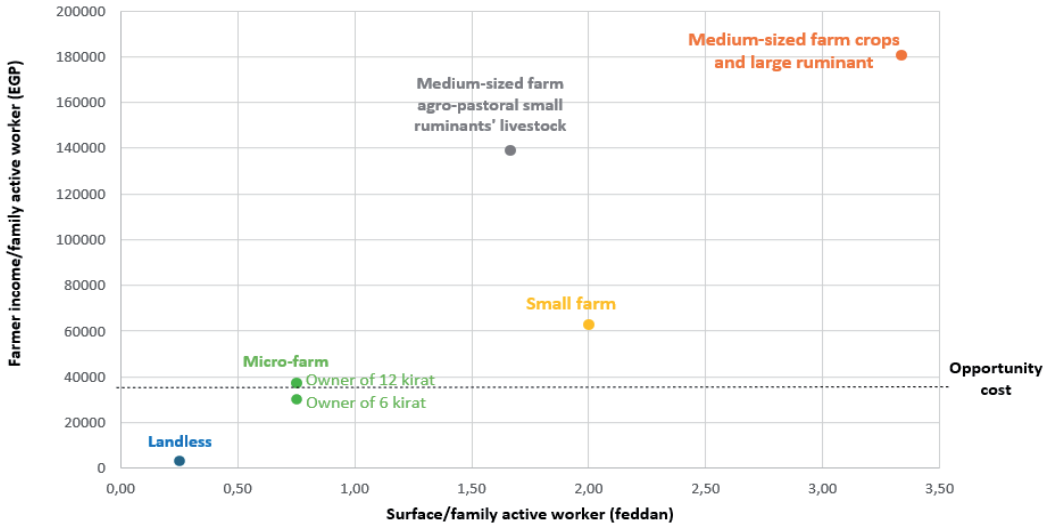

Figure 3: Farmer income as a function of the surface area by family active worker of different production systems /// *Revenu de l'agriculteur en fonction de la surface par actif familial de différents systèmes de production*

time to manage livestock and fodder. Therefore, livestock management is mainly the wife's role, and she cannot graze the herd for social reasons. This limits their access to grazing resources at the edges of fields, canals, etc. Farmers who already have mixed small ruminant livestock (1-2 does and 1-2 ewes) say that they prioritize increasing the number of ewes to produce lambs, which are "easier to manage" (according to them, in terms of grazing behaviour, goats were more likely to escape and graze on neighbouring fields).

***The micro-farms* –** low farmer incomes necessitate multi-activity, and restricted access to land hampers the development of dairy goat farming

Micro-farms are at the limit of the opportunity cost of labour (Figure 3). "*The opportunity cost corresponds to an abandonment cost. It involves understanding how much a farm household would gain or lose by leaving agriculture to allocate its labour elsewhere*" (Ferraton & Touzard, 2009). Job opportunities in the area are mainly concentrated in the surrounding towns (Itay El Barud, Damanhur) or further afield (Alexandria governorate). In the countryside, a few permanent farm labourer jobs are available nearby or in more significant numbers on the newly reclaimed land. The minimum income for these jobs is EGP 36,000 a year. Farm families with only 6 kirat (1,050 m^2) in owned land are generally obliged to rent the equivalent or more in land or buy feed and food on the market; these additional costs dramatically affect the net income that falls below the opportunity cost of labour (Figure 3). These farms are, therefore, vulnerable to variations in rent and input prices. This also explains the decision of some young people to sell their land or leave it to their brother and move to the city if they have the opportunity. The others are multi-active; they maintain their farming activity and work as casual labourers or in other types of jobs if the opportunity arises.

Micro-farmers' interest in developing a goat activity depends initially on the family's financial needs. If the husband already has a well-paid, full-time, off-farm job, he is unlikely to make any changes to the farm. When the husband works more as a casual labourer in addition to farming, the interest is more significant. However, the limited land to which they have access restricts their ability to diversify. Raising dairy cows remains a priority for the family. When the cow's feed and the family's consumption are deducted from the total production of cereals and fodder, there is very little left to feed other animals, such as dairy goats. Thus, this complicates the development of this type of breeding.

***The small farms* –** a production system conducive to the development of dairy goat farming

The surface area of small farms, around 2 feddans (0.84 ha) per worker, can generate an income almost double that of a permanent farm worker (EGP 62,000) (Figure 3). However, the question of the long-term survival of these small farms arises; any change in the family, such as the death of the father or brother, challenges the viability of the farm with the risk that the land will be split into several micro-landholdings (Figure 4). Whereas 1.5 people used to work full-time on the farm, it will become several farms where the family workers will be multi-active, assuming enough off-farm work is available.

Small ruminants are often reared in these systems, but moving towards mixed goat rearing with a higher milk production is an option to increase income. Farmers can access sufficient land to maintain dairy cows while developing the dairy goat activity. If the activity is sufficiently profitable, they can also rent additional land. Working time is not an obstacle, as this diversification, mainly through milking, would add only 10 days of work per year. Women also have experience milking goats by hand, as they milk them to dry them off after weaning. As these farmers already have cows, they often have enough space in their homes (outdoor shelters and/or livestock rooms on the ground floor) to keep more animals. In the context of high inflation, the current limitations would be the capital available to buy goats and concentrated feed, and the lack of specific skills as in the previous type.

***The medium-sized farms* –** families who prefer to focus on raising dairy cows and cultivating high-value cash crops

Medium-sized farms that cultivate cash crops and raise large ruminants have the highest income and area per worker (Figure 3). Overall, they expressed little interest in diversifying their activities with goat farming. They prefer to add value to their land by cultivating high-value cash crops and raising large dairy ruminants or fattening calves.

***The medium-sized farms with agro-pastoral small ruminant breeding* –** a system focused on raising meat sheep

The other medium-sized farms with agro-pastoral small ruminant breeding support more family members while maintaining an income of 140,000 EGP per year per active member (Figure 3). However, this system can only be sustained long term if the farmers continue to find plots of berseem and crop residues for grazing at an affordable price.

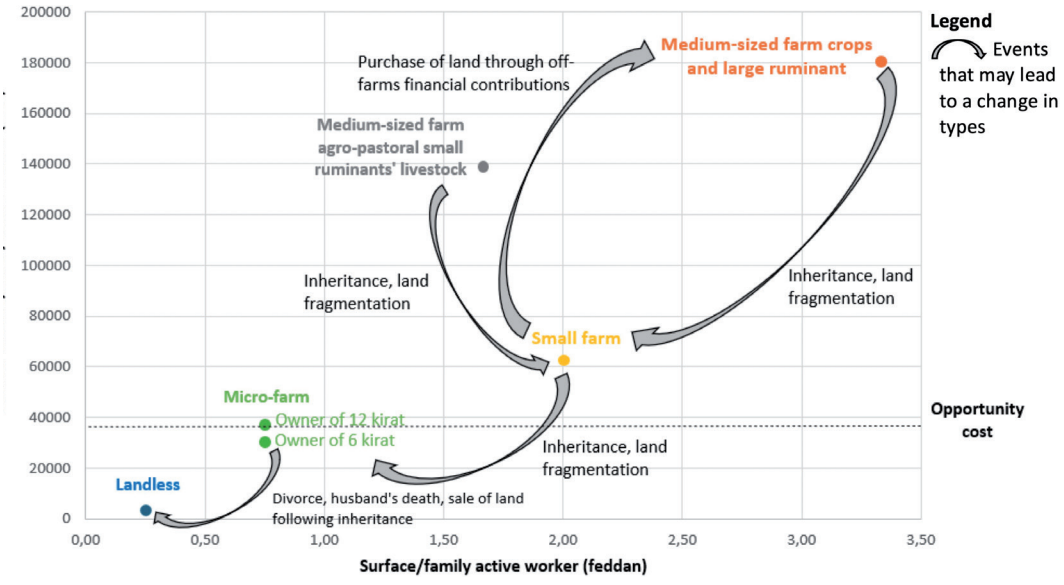

Figure 4: Potential trajectories of production systems based on various factors, with some families highly vulnerable /// *Trajectoires potentielles des systèmes de production en fonction de différents facteurs, avec certaines familles très vulnérables*

If the status of the family changes, and some family members manage to find non-agricultural employment, then the inheritance will not be divided. Otherwise, the inherited farm is at risk of being divided, with land and livestock being split among the brothers. If that is the case, it will be challenging for each of them to rebuild a viable herd with the land that they inherit, and they may be at risk of sliding towards a small-scale farm (Figure 4). These breeders are truly focused on meat production and increasing the number of ewes rather than diversifying or redirecting towards a dairy goat activity. This would require them to manage their herds very differently, since many of them have no sheepfold, and to redirect their herds towards more goats (often few in number in current herds) and different breeds. However, the bucks from these herds could continue to play their role as sires for the goats of other small farmers, for example, through the introduction of Zaraibi bucks.

Thus, small farms appear to be the most inclined to turn towards this type of diversification. That is why an economic simulation of the diversification of this production system towards dairy goat farming was carried out.

Potential for diversification into dairy goat farming from a value chain perspective

The dairy products consumed in Egypt today are almost exclusively made from cow or buffalo milk. If goat milk is produced, how then may it be collected, processed, and marketed?

In terms of collection, the collection channels for milk from large ruminants are already well developed, with small and large collectors using tricycles or pickups to collect milk from families every day. The collectors are already accustomed to separating cow milk from buffalo milk in different cans. Discussions with the collectors revealed the possibility of collecting another type of milk if downstream factories are ready to buy from them. If goat milk production is developed among families who already have large dairy ruminants and sell their milk to collectors, the latter could at the same time collect the goat milk, even if it is limited to 23 litres. The margin for small collectors varies on average between 0.7 and 1 EGP per litre of milk, and for large collectors, between 1 and 1.5 EGP per litre.

Several actors process cow and buffalo milk. Some women directly sell the milk and dairy products they process (Karish, Mish, and ghee) on the market. Milk collectors sell to collection centres and traditional or modern processing factories. The lack of refrigerated transport throughout the milk marketing chain causes milk spoilage problems. Some collectors use a variety of fraudulent practices to slow the rate of spoilage, such as adding starch to the milk to reduce its acidity. In the study area, three factories were identified, two of which were surveyed: a medium-sized modern factory called Cariby (which also acts as a collection centre) and a small traditional factory.

The potential for processing goat milk via these options and creating a new cooperative processing plant was explored. The option that seems most accessible is that of a modern medium-sized factory, such as the Cariby factory. Established in 2022, it is expanding rapidly and seeking to diversify its products. Their suppliers are collection centres that receive milk from small farmers and large dairy cow farms in newly reclaimed land in the western part of the Delta, and collectors who buy milk from small farmers in the area. The products include *Karish* and *Domiati* white cheeses, cream-enriched cheeses, mozzarella, feta, *Ras* cheese, processed cheese, cream, and ghee. They already have production resources and equipment, and recently acquired a machine for making yoghurt, which could be of interest when processed from goat milk. Moreover, working with a small quantity of milk does not seem to be a limit for this plant, provided that its sanitary quality meets the requirements of supermarkets and hypermarkets. The company is targeting middle-income to affluent consumers who frequent supermarkets such as Carrefour, Fathallah, Metro, etc., and restaurants, which makes it attractive to market goat milk products.

Another option for processing goat milk would be to set up a new, small-scale processing plant. This could be a private or cooperative initiative. A cooperative project would have the advantage of reducing the number of intermediaries, which could result in a higher purchase price for the milk from the producer. However, social and financial assistance would be required to set up the processing plant, as farmers have minimal financial capital, access to credit, or marketing support. In addition, beyond the mutual support relationships between farmers, no cooperative structures other than the state cooperatives that distribute subsidized fertilizers exist or appear to have existed in the past in the villages studied. Families in the area are reluctant to show their animals or reveal how much milk they produce to neighbours or strangers. In addition, during the interviews, the women mentioned the difficulty of going to work in other villages. Certain social and cultural obstacles could make setting up a cooperative structure of this type difficult. Meanwhile, it should be noted that women's direct sales of dairy products and live animals allow them to manage cash flow. However, when milk is sold to a collector, this management generally passes into the hands of the men.

At the consumer level, the study revealed that marketing is limited to a niche market: only 14% of those surveyed would like to consume more of these products, and only 20% would like to consume goat cheese, costing more than EGP 350/kg (Table II). The narrowness of this market can also be seen in the very low market presence of goat milk-based dairy products in Egypt.

A marketing channel for dairy products, mainly made from cow milk, is developing increasingly via Facebook groups (Table III). Very rarely, some people sell goat milk and cheese, the source of which has not been identified. In addition to marketing in supermarkets, restaurants, and hotels, direct online sales with delivery in major cities such as Alexandria could also be an interesting option to explore.

The consumer survey also provided an overview of dairy product consumption. The most commonly consumed types of cheese are white cheeses and the traditional hard cheese called *Ras* (Table II). Overall, Egyptians are not used to eating strongly flavoured cheese. Therefore, the production of fresh goat cheese could be of interest, as it is less intense and has a better milk/cheese yield than mature cheese (the return on investment would be quicker). However, this type of cheese is perishable, so it must be sold quickly. Yoghurt consumption is very high, with 84% of people consuming it, and there is a wide range of products on the market, particularly in supermarkets. Finally, 92% of people eat dairy desserts from time to time, the main ones being rice pudding and ice cream (Table II). Alexandria is home to many ice cream shops catering to working and wealthy classes.

In this context, since goat milk production would be limited, it may be interesting to start with products with a high yield in terms of quantity of milk/quantity of product, such as yoghurt or ice cream, which have yields of 100% on average. However, while yoghurt production requires little equipment (pasteurization tank, yoghurt maker, manual packaging machine), ice cream production requires more equipment (pasteurization tank, turbine, chiller-maturation, freezing cell, storage cabinet). Moreover, the manufacture and marketing of ice cream requires a stricter cold chain, which can be difficult in a context where cold chains are not very well developed or respected. In a second phase, product diversification could be interesting, for example, by introducing fresh cheese production. Given the local availability of cow milk, a mixture of cow milk and goat milk could be envisaged to increase yields (the average yield for fresh goat cheese is 13 to 20%, while that for cow milk is 20% (Chambre d'Agriculture Loire, 2012)), reduce production costs and soften the taste of goat milk.

Table II: Summary of online consumer survey /// *Résumé de l'enquête en ligne auprès des consommateurs*

Number of people surveyed	**57**
Main places to purchase dairy products (% of responses)	
Traditional dairies	36
Middle-class supermarkets	29
Farmers from rural areas	17
Other	18
Most popular types of cheese (% of responses)	
Cottage cheese (*Karish*, *Domiati*, etc.).	31
Ras cheese	29
Mozzarella	16
Other	24
Percentage of people who eat yoghurt (%)	84
Percentage of people who eat dairy desserts (%)	92
Spending on dairy products/week (% of responses)	
0-150 EGP	28
150-250 EGP	37
250-400 EGP	21
> 400 EGP	14
People who have changed their dairy consumption habits due to inflation in 2023 (%)	84
By reducing the quantity purchased	78
By purchasing other products	22
Percentage of people who regularly consume goat milk products (%)	3,5
Percentage of people who would like to consume more goat milk products (%)	14
People willing to buy goat cheese at over EGP 350/kg (%)	20
Goat meat consumption (%)	
Never	52
Occasionally	46
Regularly	2
Percentage of people who would like to eat more goat meat (%)	39

Table III: Goat milk dairy products sold through various marketing channels in Alexandria, Egypt /// *Produits laitiers à base de lait de chèvre vendus par divers canaux de commercialisation à Alexandrie, Egypte*

		Product	**Price/kg (EGP)**
Supermarket for the wealthy class (Fresh Food, Metro, Carrefour)		*"Malika"* brand *Labneh* balls	240
		Fresh goat cheese (50% goat milk and 50% cow milk) *"Ma chèvre"* brand	580
Online sale	**Start-up *Tayyiba Farms***	Pasteurised milk	105
		Greek yoghurt	258
		Milk kefir	143
		Labneh	400
	Facebook groups	Milk	50
		Cheese	350

Table IV: Calculating the purchase price of goat milk from the farmer /// *Calcul du prix d'achat du lait de chèvre à l'éleveur*

Yoghurt final price 1 (EGP/kg of yoghurt)	100
Yoghurt final price 2 (EGP/kg of yoghurt)	150
Collector margin (EGP/kg of milk)	3
Cost of manufacturing materials (EGP/kg of yoghurt)	9
Processing factory margin (% of yoghurt price)	5
Transport cost (% of yoghurt price)	5
Retailer margin (% of yoghurt price)	25
Margin of error (% of yoghurt price)	10
Price 1 of milk bought from farmer (EGP/kg of yoghurt)	43
Price 2 of milk bought from farmer (EGP/kg of yoghurt)	71

Economic simulation of diversification with a dairy goat system for small farms

Three prices for cow milk-based yoghurts of different brands, ranging from 56 to 68 EGP/kg, were recorded in affluent supermarkets. The start-up Tayyiba Farms sells its Greek yoghurt made from goat milk directly at a price of 258 EGP/kg (Table III). However, this price seems high compared with the responses of the people surveyed and with the current inflation affecting Egypt. To carry out the economic simulation, we assumed that plain goat milk yoghurt could be sold at an average price of 100 to 150 EGP/kg and be manufactured by an existing factory. With the deduction of production and transport costs and the margins of the various intermediaries, we obtained a purchase price for goat milk from the producer of between 43 and 71 EGP/kg (Table IV).

To assess the impact of diversifying into mixed goat farming on the income earned per family worker, we replaced small ruminants with Zaraibi goats reared for both milk and meat production. In the simulation, the feed required increases but remains based on berseem, fresh in winter and dry in summer, for milk production, supplemented by rice straw. A concentrated mix of wheat bran, ground maize, cottonseed cake, and molasses are also distributed.

In terms of reproduction, two options are envisaged. The first is that a buck is shared between an average of three farmers in the village, meaning there is one buck for every 15 goats. Under this option, the buck stays with each farmer for several days during the breeding season, so the reproduction period is staggered slightly between farmers. For the remaining time, we considered that the farmers would share custody of the buck. The advantage of this option is that mating can take place while the goats are still lactating, so the production cycle is shorter (300 days). The kids are weaned at an average of 4 months, and lactation lasts 7 months. During the first 4 months, milk is withdrawn partially, then totally during the following 3 months, giving 134 litres per head per year. The second option is for farmers with large herds of small ruminants to buy Zaraibi bucks. In this case, smallholders can continue to take their goats to these breeders for breeding. However, this means that mating can only occur at the end of lactation and, therefore, the production cycle is longer (374 days). The goat is dry for 5 months; milk production is 120 litre /year/head.

The increase in income per worker is 28% for a milk price of EGP 43/kg and reproduction by a large agri-breeder, and 54% for a milk price of EGP 71/kg and reproduction by a buck shared between breeders (Figure 5). A buck shared between farmers would allow for higher

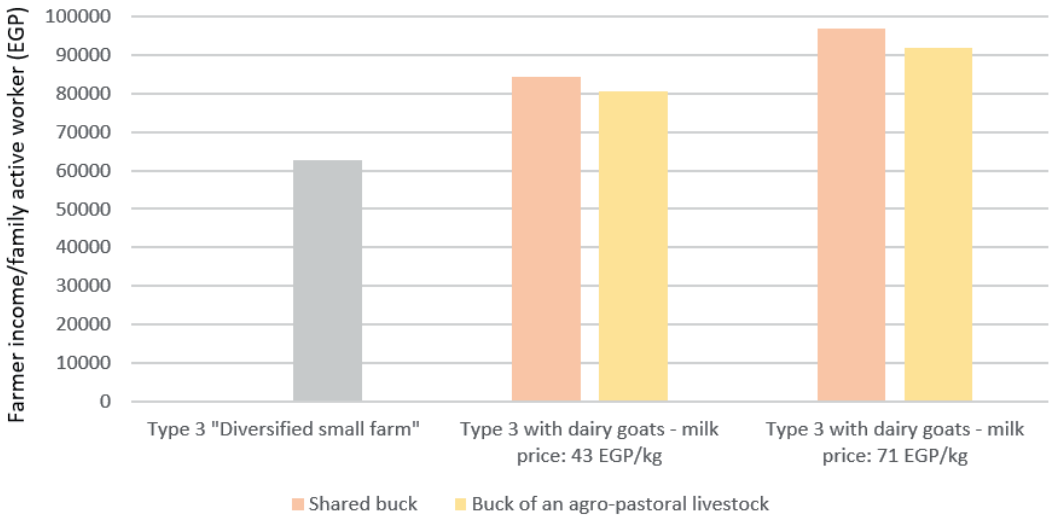

Figure 5: Comparison of income by family active worker for a small diversified farm according to whether and how dairy goat livestock are included /// *Comparaison des revenus des actifs familiaux d'une petite exploitation agricole diversifiée en fonction de la prise en compte ou non du cheptel caprin laitier*

annual kid production and milk production despite the additional feed and care costs. Replacing the small ruminant farming system on small farms with a system of five Zaraibi goats for producing and selling milk would therefore appear to be an interesting way of increasing income per worker while maintaining the cultivated area. It should be noted that farmers are interested in diversification, and not in replacing large dairy ruminants with mixed-breed goats. Goats produce around 10 times less milk than cows, whose milk is essential for the food security of both rural and urban families. Finally, the impact on working time is very slight, with annual working time increasing by only 10 days due to the addition of daily goat milking.

■ CONCLUSION

This study used a systems approach to determine whether raising dairy goats could be interesting for small integrated crop-livestock farms in the Delta. It showed that below a utilised agricultural area (UAA) of 18 kirat (3150 m^2), the income/family active worker falls below the opportunity cost of labour, and it becomes challenging for the family to live exclusively from farming. They therefore need access to other local employment opportunities. In contrast, small and medium-sized farms of 3 feddans (1.26 ha) or more manage to generate an income/family active worker that exceeds the opportunity cost and is sufficient to live exclusively from farming. Nonetheless, small farms are vulnerable to changes in land rental prices and land fragmentation with inheritance, which causes them to slide towards micro-farms and pluri-activity. However, in the context of the economic crisis, and with many young people entering the job market, it is hard for youth to find a job and engage in an activity.

To reduce this vulnerability, replacing the current small ruminant breeding system on small farms with a Zaraibi goat breeding system with goat milk valorisation would increase income per worker by 28% to 54%. However, to develop this production, and in a context of high inflation, farmers need support to purchase these local high-yield goat breeds, which are not very common in the area, and the concentrated feed used for milk production. In the local context, this diversification would require a larger supply of berseem hay (1.2 tonnes for five goats), which would, in turn, require additional labour. If berseem, which is essential for renewing soil fertility, is grown in greater quantities, it would be at the expense of wheat, which is important for food security.

Given the minimal availability of grazing land, a better use of crop residues, such as potato, sweet potato, and cabbage residues, as well as household residues, could help reduce production costs. In the context of a dairy business and the valorisation of milk, it would be relevant to work on access to veterinary care and to carry out milking in good sanitary conditions. We also need to look at reproduction to see whether sharing a buck between several breeders - the most economically attractive solution - is feasible and what type of organization could be implemented.

A major challenge for developing this type of farming lies in processing and marketing, as the market for goat milk is an underdeveloped niche market. Working with the cow milk collection circuit and existing small and medium-sized factories with marketing channels targeting middle-class and affluent consumers is an economically attractive prospect. However, selling goat milk to collectors presents a risk in terms of income distribution within families. Indeed, women are the main processors and sellers of dairy products, which generally allows them to manage the cash flow from this activity. The choice of processing (within families, in cooperatives, via private factories) and marketing methods would therefore have a major impact on the gendered distribution of income. Thus, the development of such a project would require particular attention to the role of women in its construction and evolution over the long term.

Furthermore, in terms of the production system, once the kids have been weaned, the amount of milk collected daily for five goats is 3.5 litres. This small quantity requires the involvement of many local farmers in such a project to set up viable processing and marketing. This study also has revealed significant inter-annual variability in the number of small ruminants within families. This variability, which is influenced by each family's financial needs, could affect the stability of milk production. In addition, exploring the crossbreeding of local goats with other breeds from the Mediterranean basin that have better milk production and a capacity to adapt to the local environment could be a valuable option.

Finally, improving the water and economic situation in these deltaic lands also is a prerequisite for increasing farmers' incomes. We therefore need to focus on organizing canal water distribution and maintaining irrigated canals, as well as improving farmers' access to credit and the financial capacity of state cooperatives to diversify their activities beyond the sole distribution of fertilizers.

In summary, the results of this study suggest that raising goats for milk could be a viable opportunity for small, integrated crop-livestock farms in Egypt's Nile Delta, but only under specific conditions and with targeted interventions. From a critical perspective, these findings underscore the fragile balance between economic viability and

structural constraints in small-scale farming systems. Diversification into goat milk production can enhance small farmers' incomes and resilience, but requires investments in goats, feed, and infrastructure, alongside better access to credit and subsidies. The niche goat milk market risks excluding smaller producers, but cooperative models, as observed in India and Pakistan, could inspire the development of a sustainable goat milk value chain. Notably, cooperative models like Amul in India offer key insights into the matter of ensuring fair pricing and facilitating access to resources and infrastructure improvements (Parekh, 2019). Training farmers in scientific livestock management, as done in the Indian model, and targeting niche markets for goat milk products, similar to Pakistan's success with value-added items (Sharif & Farooq, 2004), could boost productivity and profitability. Public-private partnerships and inclusive social equity programs can also attract investments, improve processing and logistics, and empower marginalized groups. In conclusion, while raising goats for milk presents a promising path for small farms in Egypt's Delta, a multi-faceted approach involving policy support, market development, and farmer organization is critical to unlocking its full potential.

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Conflicts of interest

The study was carried out without any conflict of interest.

Author contributions

LH, TA, AAN, VA: participated in the design and planning of the study. LH: collected, analyzed, and interpreted the data and wrote the first draft of the manuscript. TA, MM: participated in data collection. TA, AAN, VA: revised the manuscript.

Ethics approval

All involved persons gave their written informed consent before taking part in the workshops and interviews.

Data availability

The data were not deposited in an official repository. The data that support the study findings are available from the authors upon request.

Declaration of Generative AI in the writing process

The authors did not use any artificial intelligence-assisted technologies in the writing process.

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Résumé

Hautbout L., Abdelsabour T., Aboul-Naga A., Moghazi M., Alary V. L'élevage de chèvre pour leur lait peut-il être une opportunité viable pour les petites exploitations agricoles intégrant cultures et élevage dans le delta (Egypte) ?

Contexte : L'Egypte, troisième pays le plus peuplé d'Afrique, connaît une fragmentation intense des terres dans le delta du Nil, la plupart des exploitations agricoles faisant moins d'un demi-hectare. L'agriculture, qui emploie 30 % de la population, est confrontée à des problèmes de pénurie d'eau et de baisse de la fertilité des sols. Les grands ruminants sont de plus en plus difficiles à élever en raison des coûts élevés des aliments, aggravés par la dévaluation de 2016 et la guerre Ukraine-Russie de 2022. ***Objectif*** : Cette étude explore les stratégies de diversification dans les petites exploitations de Beheira (delta du Nil), en se concentrant sur le potentiel des petits ruminants comme alternative économique. ***Méthodes*** : La présente étude propose d'analyser les systèmes agricoles en utilisant l'approche agraire, en collectant des données à travers des observations du paysage et des entretiens avec des agriculteurs menés en 2023. Une analyse technico-économique évalue les performances des exploitations et des simulations explorent les avantages économiques de l'intégration des chèvres Zaraibi, en se concentrant sur le mode de reproduction et le prix du lait de chèvre. ***Résultats*** : L'introduction de chèvres Zaraibi pourrait augmenter les revenus agricoles de 28 à 54 %, mais les défis restent nombreux, dont notamment une inflation élevée, l'accès limité à l'alimentation et aux pâturages. ***Conclusions*** : Une meilleure utilisation des résidus de récolte, des soins vétérinaires et une meilleure organisation des éleveurs à l'échelle locale sont essentielles. Le marché du lait de chèvre est très balbutiant, ce qui nécessite aussi l'organisation de réseaux d'acteurs entre l'amont et l'avant. En outre, une meilleure gestion de l'eau et un meilleur accès au crédit sont des clés essentielles à la durabilité des exploitations agricoles.

Mots-clés : Caprin, lait de chèvre, système d'exploitation agricole, diversification économique, création de revenus, Egypte

Resumen

Hautbout L., Abdelsabour T., Aboul-Naga A., Moghazi M., Alary V. ¿La cría de cabras lecheras puede ser una oportunidad viable para las pequeñas explotaciones que integran cultivos y ganadería en el delta (Egipto)?

Contexto: Egipto, tercer país más poblado de África, experimenta una fragmentación intensa de las tierras en el delta del Nilo: la mayor parte de las explotaciones agrícolas son de menos de media hectárea. La agricultura, que ocupa al 30 % de la población, se enfrenta a problemas de penuria de agua y de reducción de la fertilidad de los suelos. Cada vez es más difícil criar a los grandes rumiantes a causa de los elevados costes de los alimentos, agravados por la devaluación de 2016 y por la guerra Ucrania-Rusia de 2022. ***Objetivo***: Este estudio explora las estrategias de diversificación en las pequeñas explotaciones de Beheira (delta del Nilo), concentrándose en el potencial de los pequeños rumiantes como alternativa económica. ***Métodos***: Se propone analizar los sistemas agrícolas utilizando el enfoque agrario: recopilando datos mediante observaciones del paisaje y entrevistas con los agricultores llevadas a cabo el 2023. Un análisis técnico-económico evalúa el rendimiento de las explotaciones, y las simulaciones exploran las ventajas económicas de la integración de las cabras Zaraibi, concentrándose en la forma de reproducción y el precio de la leche de cabra. ***Resultados***: La introducción de cabras Zaraibi podría aumentar las rentas agrarias en un 28 a 54 %, pero los retos todavía son numerosos, especialmente la inflación elevada y el acceso limitado a la alimentación y a los pastos. ***Conclusiones***: Son esenciales: una mejor utilización de los residuos de cosechas, curas veterinarias y una mejor organización de los ganaderos a escala local. El mercado de la leche de cabra es incipiente, lo que requiere también la organización de redes de actores, entre aguas arriba y aguas abajo. Además, una mejor gestión del agua y un mejor acceso al crédito son esenciales para la durabilidad de las explotaciones agrícolas.

Palabras clave: Caprino, leche de cabra, sistema de explotación, diversificación económica, generación de ingresos, Egipto