Asian Journal of Agricultural Extension, Economics & Sociology

39(11): 102-113, 2021; Article no.AJAEES.74707
ISSN: 2320-7027

Local Production and Commercialisation of Milk from Holstein Cows in the Grassfields of Cameroon: Contribution to Improving Living Conditions in Rural Areas

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Authors' contributions

This work was carried out in collaboration among all authors. Author HMN designed the study, wrote the protocol, carried out the field study, managed the bibliographical research, carried out the statistical analysis and wrote the first version of the manuscript. Authors FDE and POA designed the study and approved the protocol and the bibliographical research. Author AM made the map of the study area. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/AJAEES/2021/v39i1130730
Editor(s):
(1) Dr. Roxana Plesa, University of Petrosani, Romania.
Reviewers:
(1) Gezu Tadesse Mammo, Wachomo University, Ethiopia.
(2) Suntorn Wittayakun, Rajamangala University of Technology Lanna, Thailand.
Complete Peer review History: https://www.sdiarticle4.com/review-history/74707

Original Research Article

Received 08 August 2021
Accepted 15 October 2021
Published 21 October 2021

ABSTRACT

The role of livestock farming is no longer to be demonstrated in rural areas. Livestock provide income and facilitate access to food in rural areas. The aim of this article is to analyse the local production and marketing of milk from Holstein cows in the Grassfield (North West and West regions) of Cameroon in order to understand how much Holstein farming contributes to the rural economy. The data was collected using a questionnaire administered to 325 households producing

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milk from Holstein cows only. These households were selected on the basis of the existence of milk production units in the study area The data were analysed using SPSS version 20 software and Excel. Analyses of the data collected reveal that; the average milk production of cows in Grassfields varies from one lactation stage to another (7.75 liters/ day in the beginning of lactation to 17 liters / day at the end of lactation) with a daily average of 12.83 liters per day. The milk production of Holstein cows in the study areas is higher in Noun division (10 to 20 liters / day) than in Mezam division (5.5 to 14 liters per day). The profit margin generated by large producers is 230,100 CFA francs per month. On the other hand, the small producers have a profit margin of 33,800 CFA francs per month. The chi-square test of independence showed that $X^2 = 5.756$ and the probability (sig) = 1.6% which is less than 5%, which implies that the result is significant at 5%. The rotating saving groups contribute to the improvement of incomes. They therefore play a role in financing production. The evaluation of the contribution of rotating saving and credits association in improving the standard of living of households producing Holstein milk has shown that rotating saving association contribute significantly to the financing of the production of milk in production units, the education of children in breeding households. Rotating saving groups facilitate access to household food and healthcare. This economic activity of production and commercialisation of milk from Holstein cows certainly makes it possible to meet the daily needs of households, but it remains an informal activity in view of the production environment. The strong involvement of the public authorities is therefore necessary to make milk production a sector of the economy, although production and marketing activities are currently impacted by the COVID-19 pandemic.

Keywords: Commercialisation; grassfield; holstein; local milk production.

1. INTRODUCTION

Milk is one of the animal products which is increasingly being used to meet the food needs of the fast growing population [1]. In Cameroon, the average milk consumption was estimated at 8.3 kg / capita / year in 1996 [2] to and decreased to 7.81 kg / capita / year in 2006 [3] and increased to 14.6 kg / capita / until today [2]. However, despite the large potential for good production that the country has in its western and north-western regions, the current production is estimated at 174,000 tonnes [4], which represents a deficit of 120000 tonnes To compensate the deficit of production relative to consumption the country relay on imports of milk and dairy products [5]. This implies significant losses in foreign currency. Therefore, an increase in the country's milk production is urgently necessary to reduce these losses. However, dairy production in Cameroon is mainly carried out under poor technological conditions by traditional breeders who own 80 to 85% of the national cattle herd [3]. Attempts to improve this production have been made through the introduction of more efficient imported dairy breeds and their cross-breeds with local Zebus [6].

With a herd estimated at six million cattle [3], made up of the M'bororo and Goudali zebus and a few breeds imported from Europe (Montbéliarde, Salers, Brahman, Taurin), the Cameroonian pastoral sector followed a prosperous period until 1986 in a market production of live animals and milk production providing employment and cash income to households. Indeed, since August 21, 1986, the Grassfield breeding basin has experienced a natural disaster in its history. The sudden explosion of Lake Nyos, a crater lake perched at about 1,100 meters above sea level, which released more than a cubic kilometer of poisonous carbon dioxide. Nearly 2,000 people died of asphyxiation in their sleep, as did several thousand cattle [7]. This disaster plunged the population, mostly pastoralists, into overwhelming poverty.

In national and international solidarity; the American project, Heifer International (HPI), introduced the exotic dairy breed “Holstein” to bring this population back to life. This policy of aid to rescued peasants displaced and settled in the surrounding villages 40 km from the site of the disaster, benefited from the dairy breed to reconstitute their herds to compensate for the losses of animals and to redo an income-generating activity in the economy of traditional market dairy production, and to fight against poverty in different households, ie every woman should receive a donation of a cow [8].

Nevertheless, improved Holstein breed, which is highly productive requires an intensive production system in terms of infrastructure

management, food, health, etc. however given its requirements, the introduction to peasants can be at the centre of impoverishment mechanisms if a sustained mechanism of funding and technical support is not provided [9,10]. Thus, a support system and project monitoring for the beneficiary producers have been put in place. There was not need to rely on traditional savings and credit circuits as there was resounding bankruptcies everywhere which had resulted in costly restructuring of banking establishments, which are very reluctant to grant agricultural credit to producers [11,12].

Faced with the difficulties of access to the banking system by rural producers to improve dairy activity, in its frantic search for ways and means developed in breeders' associations, the dairy income rotating savings and credit associations [13]. This traditional form of savings and credit seems particularly well suited to the rural world, [14,15] insofar as producers who are better organized in association, can draw more from traditional forms of solidarity to bring together and mobilize resources (financial or other) needed to finance development. The success of the rotating saving has led to the belief that these structures can replace banks and insurance companies in the African financial system.

In its second phase of dairy development, the American Heifer Project International (HPI) extended this breeding policy to Noun in the West region of Cameroon. The marketing of dairy products therefore led women beneficiaries to practice income saving with the objective of meeting daily family needs and self-finance personal activities (children's education, health care, etc.). Thus the environment of milk production and breeding of dairy cows, the development of the commercial activity of dairy sales and rotating savings explicitly induces a questioning: Can the local production and marketing of cow milk from the Holstein breed help improve the standard of living of producers in the Grassfield area of Cameroon?

The present research aims to analyse the local production and marketing of milk from Holstein cows in the Grass fields (North-West and West regions of Cameroon) with regard to poverty reduction strategies in order to understand to what degree the breeding of the Holstein contributes to the rural economy. More specifically, this study aims to show the contribution of the economic activity of production and marketing of milk from Holstein cows in the improvement of living conditions through milk income rotating savings and credit associations.

2. RESEARCH METHODOLOGY

2.1 Description of the Study Area

The study was conducted in two regions (refered to as Grassfields) in Cameroon. These are the West and the North-west regions. The data were collected in the Noun division located in the West region and in the Mezam division located in the North-west region. The Noun Division covers an area of 7687 km^2 covering 55.35% of the total area of the Region and has a population of 455,083 inhabitants [16] with a density of 38.80 inhabitants per km². However, with a growth rate of 2.8% each year, this population is currently estimated at 633,475. The Noun division has a total of 9 municipalities. As for the Mezam division, it covers an approximate area of 1,745 km^2 covering a population of 465,644 inhabitants with a density of 267 inhabitants per km2. It has a total of 7 municipalities. The climate is tropical Sudano-Guinean humid tropical type for the Noun division and is equatorial type Cameroon for the Mezam division. Both regions have a long rainy season from March to October and a short rainy season from November to February. Agriculture is the main activity for both regions as it employs nearly 90% of the population.

2.2 Sampling Techniques and Sample Size Determination

In Cameroon there are several breeds of cows depending on production objectives and climatic conditions. We distinguish the local meat breeds made up of the M'bororo and Gudali zebus and dairy breeds imported from Europe made up of the Holstein and Montbéliarde breeds. But this study was only focused in the Holstein breed. Depending on the objective of the breeding which is the milk production and the climatic conditions, the Holstein breed is the best adapted in the grassfields of Cameroon.. Thus the study was carried out only with households of Holstein dairy production in the Noun and Mezam divisions, both belonging to the same agro-ecological zone (the Highlands zone of West Cameroon). Production units were identified with the help of extension agents in the study area. Given the relatively small number of households producing Holstein dairy cows, there was no need to carry out a sampling plan. All herding households listed by the extension

agents were interviewed. The districts were chosen on the basis of the existence of dairy production units in the area. It is for this reason that 5 out of 9 sub-divisions were selected in the Noun division and 3 out of 7 sub-divisions in the Mezam division. These include the Foumbot, Kouoptamo, Bangourain, Koutaba, and Foumban subdivisions which are designated as main milk production basins and constitute the centres of supply of large quantities of milk in the Noun division and Bali, Tubah, Bamenda 1 in the Mezam division. The choice of villages by subdivision was conditioned by the presence of production units in the area. 16 villages out of 68 were chosen in the 8 sub-divisions because of the presence of Production units in these sub-divisions. In the 325 existing production units in the study areas, all were selected for the survey because of their relatively small number.

2.3 Method of Data Collection

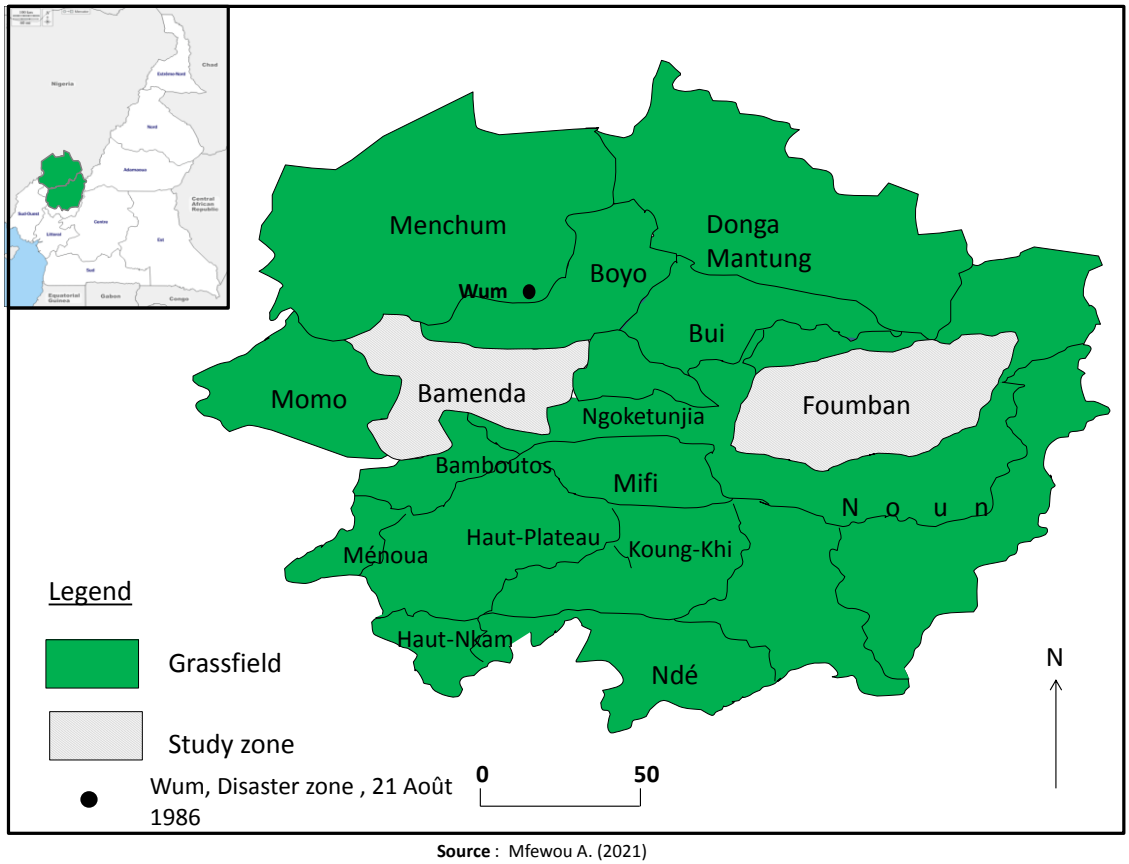
Two data sources were used namely, primary and secondary sources. The primary data were collected using a questionnaire, direct observations and focus groups organized on the basis of the objectives of the study and information previously collected. Secondary source data was obtained through reviewing documents such as scientific articles, scientific reports, and activity reports. Data were collected using a rational sampling technique due to the relatively small number of production units.

2.4 Methods of Data Analysis

This study used descriptive statistics, the calculation of the gross margins of the different types of dairy producers, and the Chi-Square Independence test to analyse the data from sample households in the study area using the SPSS software version 20 and Excel version 13. Content analysis was done to interpret qualitative data.

2.4.1 Descriptive statistics

Descriptive statistics such as frequencies and averages were used to summarize data collected from milk producing households. Descriptive statistics were used to draw up the zoo technical characteristics of the production units.



Source : Mfewou A. (2021)

Image 1. Geographical location of holstein breeding study area in Grassefield (Cameroon)

2.4.2 Determination of profit margins

The financial evaluation was carried out to show the profitability of this economic activity of production and sale of milk. Gross margins were determined using the following model

GM = RT-CT [17]

Where:

GM = Gross margin
RT = total income
TC = total cost

2.4.3 Chi square independence test

The Chi-Square Independence Test was carried out to analyse and understand whether improving the standard of living among producers depended on the rotating saving groups. The parameters that have been used to explain what the improvement of living conditions refers to are the financing of the production of milk in production units, the education of children in breeding households, accessibility to household food and healthcare. the living conditions of herding households are said to be improved if the tontines make it possible to meet these daily household needs.

The aim of the Chi-Square Independence Test was to test the difference between producers belonging to the rotating saving groups and those who do not belonging to the rotating saving groups. For this purpose, the null and alternative hypotheses have been defined and developed as follows.

The null hypothesis of the Chi square test stated that the improvement in the standard of living was independent of belonging to a rotating saving and the alternative hypothesis stated that the improvement in the standard of living was not independent of belonging to a tontine or that improving living standards depends on income from the sale of milk.

Statistical software, SPSS 20 was used to analyse the data. The qualitative variables used in the carry out the Chi square test are stated in Table 1.

3. RESULTS AND DISCUSSION

This chapter presents results of descriptive analysis and the chi-square independence test of the study. Descriptive analysis was used to describe characteristics of milk production units in terms of housing, food, as well as the production environment. The chi-square independence test was used to evaluate the contribution of rotating saving and credits association in improving living conditions through income from the sale of milk from Holstein Cows (Fig. 1) in Grassfield of Cameroon.

3.1 Zoo Technical Characteristics of the Production Units

3.1.1 The herds

The production units studied consist only of Holstein cows. The number of cows per unit of production varies from one production unit to another. The distribution of production units according to herd size is presented in the following Fig. 2.

Fig. 2 shows that the percentage of production units with two dairy cows is higher (47.3%) compared to the production units with one cow (25.4%), three cows (20%) and four cows (7.3%).

The herd is structured in such a way that in the units studied, the cows (83.3%) are mostly lactating because after each birth the calf should be passed to a new member of the Association who has not yet animals because it was part of one of the fundamental objectives of the humanitarian organization Heifer which stipulated that: "the passage of the donation would allow the families who received animals to become in turn donors. For each animal received, the families agreed to pass on an animal born from

Table1. The qualitative variables used for chi square test

S/N	Variables	Description and measurements of variables
1	BILROSA	1 if yes and 0 if no
2	OPINION_ROSA	1 if very important, 2 if important , 3 if moderate, 4 if not necessary important, 5 if not important, and 6 if absolutely not important

BILROSA= belonging to a rotating saving
OPINION_ROSA = opinion on rotating saving

Fig. 1. Holstein cows photo

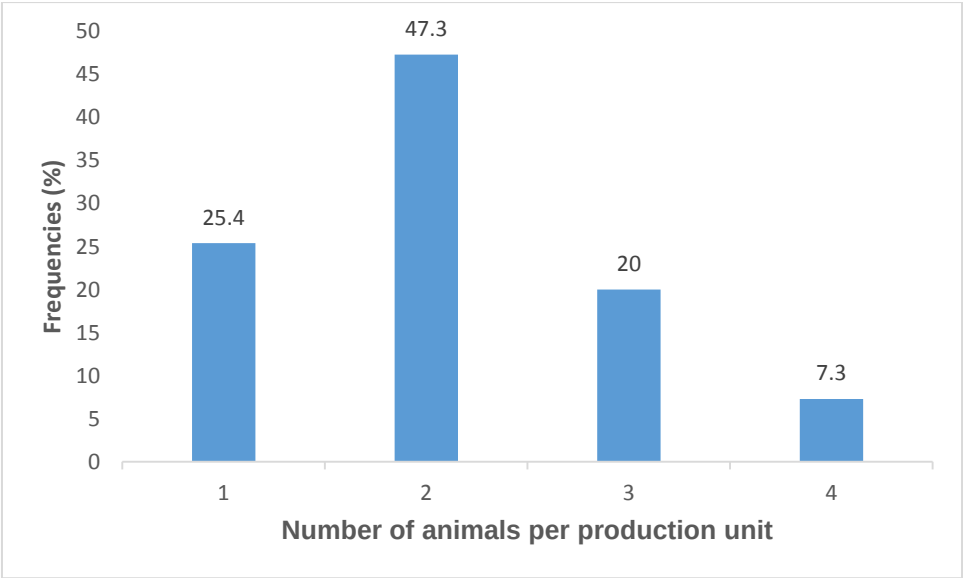


Fig. 2. Distribution of production units according to the size of the herds

the farm to another family. They also passed on their know-how and the training received [18]. This is in line with the proportions of cows recommended as references for dairy farms: that is, 50% lactating cows compared to the herd and 80% compared to all cows [19] These results contrast with those observed by [20] in the far North and [2] in the North-West, who report lower proportions of local females in extensive farms. These differences are believed to be due to the method of data collection which was based on the survey. However, these results are similar to those of [21] observed among transhumant herders.

3.1.2 Shelter and equipment

The Table 2 shows the distribution of livestock farming households according to housing and equipment. In general, this activity takes place alongside the houses of the producers.

Table 2. Distribution of production units studied according to the type of housing and equipment

Paramètres		frenquences	Proportion
Shelter	Closed in boards	307	94,5
	Closed straw pens	12	3,6
	Open	6	1,8
	Total	**325**	**100**
Feeders	Plank or slatted container	284	87,3
	Half-barrel feeders	41	12,7
	Others	0	0
	Total	**325**	**100**
Drinkers	Cement box	160	49,1
	Half-barrel drinkers	153	47,3
	Others	12	3,6
	Total	**325**	**100**

In the production units surveyed (Table 2), the housing consists only of enclosures because a part (94.5%) of these closed in planks and others (3.6%) in straw. Other dwellings are in open pens (1.8%) where the cows are not sheltered from the elements. Planks and sometimes slats are the main construction materials for these enclosures and for the tanks (87.3%) used as drinking troughs. In some dwellings the half-barrels (12.7%) are used as feeders on the one hand and as drinkers (47.3%) on the other hand. But the majority of dwellings have drinkers made of cement (49.1%) and sometimes of other materials (3.6%) such as half-cans etc.

All the animals are taken care by family members because they not only provide feed and water, but also babysitting. The breeders do not take the herdsmen for the follow-up and the maintenance of the animals, this because of the lack of financial means to ensure their salary. While herdsmen are often very interested in enhancing the herd's milk production, as Meyer and Denis signaled in 1999.

The farms surveyed (100%) have a single production objective, which is milk production because they only own dairy cows. The latter are in peri-urban areas. They deliver their production either to the Koutaba market for those who are in the Noun or feed their own artisanal dairies. In addition, it was observed that the presence of a dairy in the environment of the breeders, encourages them to take more interest in the dairy aspect of their breeding. These observations are opposed to those of [22] and [19] indicating that traditional and / or semi-intensive breeding is oriented towards mixed production (meat and milk) with a priority of meat.

3.1.3 Feeding dairy cows

Breeders have three types of feed for their livestock: natural pastures and fodder crops, crop residues, supplements. One of the main factors in reducing milk production is diet. It is the main investment item for intensive livestock farming, where it represents 60% of production costs [23]. Thus the basic ration of livestock comes mainly from the exploitation of natural community pastures or sometimes cultivated. The productivity of natural pastures varies with the seasons. Fodder is abundant in the rainy season and becomes increasingly scarce as the dry season begins. These observations confirm those of [2] who report that the basis of animal feed remains natural grazing. By explaining that animals fed exclusively on pasture generally have a low growth rate and represent only 10% of the genetic potential. Thus, supplementation is necessary. Table 3 shows the distribution of breeders according to the feeding system. It should be noted that the use of food supplements generates other costs in the production units encountered. This sometimes hurts the development of this activity.

It appears from Table 3 that 92.7% of breeders do not bring their animals to pasture, which is explained by the great distance that exists between the stables and the pastures on the one hand and on the other hand the theft of animals that have been rampant in the department for several years. However, a few breeders (7.3%) bring their grazed cows to pasture.

In all the production units surveyed, 96.4% of breeders practice fodder cultivation of species such as brachiara (Fig. 3), sylosanthes, trypsacum and many others. It should be pointed

out that these cultures are not only in small spaces, but are not as well maintained as they have not received proper training on the matter. Besides these, other breeders (3.6%) do not cultivate fodder.

After harvests in the rainy season, this fodder is directly served to the animals in their lodges because 77% of breeders do not have places for conservation, while only 23% of breeders have sheds which can be temporary or permanent for conservation. But sometimes in the dry season, the stubble of corn, beans and other agricultural by-products are kept in the stable.

3.1.4 Animal health

In terms of health, breeders face a few diseases. Table 4 shows the prevalent diseases of dairy cows in grassfields reported by veterinarians caring for these cows.

Table 3. Distribution of livestock farming households according to the feeding system

Parameters	Decisions	Frequences	Proportions
Pasture	Yes	24	7,3
	No	301	92,7
	Total	**325**	**100**
Fodder culture	No Practitioners	12	3,6
	Practitioner	313	96,4
	Total	**325**	**100**
Food supplements with concentrates	Yes	198	60,9
	sometime	68	20,9
	No	59	18,2
	Total	**325**	**100**

Fig. 3. Brachiaria field of a production unit in the study area

Table 4. The dominant diseases encountered by households raising dairy cows in grassfields of Cameroon

Dominant diseases	Frequences	Proportions (%)
Mastitis	225	69,3
Ticks	47	14,5
Diarrhea	36	10,95
Tuberculosis	11	3,45
None	6	1,8
Total	**325**	**100**

According to veterinarians, results show that mastitis is the main health constraints for the production units studied. They are listed in 69.3% of farms. These results are contrary to those observed by [20] and [2] who say that foot-and-mouth disease threatens in cattle in the far north of Cameroon. What seems to be confirmed by these results of the prevalence of trypanosomosis observed by [23].

Besides these, 1.8% of breeders have cows that show no symptoms or signs of disease. Despite the presence of diseases targeted by vaccination campaigns organized by MINEPIA, approximately 94.8% of breeders regularly vaccinate their animals against these diseases. The presence of these diseases would be further reduced if all dairy cows were indeed. These diseases have a negative impact on the amount of milk produced, hence a reduction in milk income.

3.2 Gross Margins from the Marketing of Holstein Milk in Grassfields

Farmers were categorized into small and large producers according to the level of production. Small producers are considered those who produce less than 10 litters per day and sell their milk raw and large producers are those who in addition to their own production buy the production of small producers to process into yoghurt. Large producers contribute 10,000 CFA francs to the rotating saving association and therefore have enough resources to be able to develop their dairy production activity.

3.2.1 Financial analysis of large producers

The following table presents the simplified analysis of the monthly financial profitability of large producers.

Results in Table 5 above shows that at the level of milk production and animal husbandry, animals feed on fodder and food supplement. Therefore; an animal consumes an average of 100 kg of food supplement in 1 month, or an average of 14,000 CFA francs per month that large producers spend on the purchase of food supplements.

The amount produced vary from one production manager to another. The minimum daily production is 5 litters and the maximum daily production is 20 litters, an average estimate of 12.83 litters produced per day for producers in Grassfield. Table 2 shows that the gross margin generated by large producers is 230,100 CFA francs.

This margin is much higher than that found by [3] in the Mbéré Division of the Adamaoua region which was 152,000 CFA francs and considerably lower than those found by [24] in Burkina Fasso which was 446,091 F CFA. This difference would be due to the different breeds studied which have different potential for milk production. The difference is also believed to be due to poor feeding of the cows, as feed is one of the main factors in the decline in milk production. It is the main investment item for intensive livestock farming, where it represents 60% of production costs [23].These results show that milk production contributes significantly to the income of breeding families.

In this activity, some prefer to sell their production without processing (small producers) to the farmers and others prefer to sell after processing (large producers). Processed milk costs more than unprocessed milk (raw milk) because processing generates other production costs. Raw milk costs 400F per litter and processed milk costs 1000F per litter.

Table 5. Operating account of large producers

Total costs		Total Revenue (FCFA)	
Items	**Value**	**Items**	**Value**
Cow maintenance	5000	selling price of milk	256 600 (2566 liters)
Purchase of salt	2500		
Purchase of additional feed	14 000	Oil sale price	15000
Veterinary	1500		
Counter transport	12000		
Electricity	3500		
Market taxes	3000		
TC	**41 500**	**TR**	**271 000**
GM	**230 100**		

3.2.2 The financial profitability of small producers

The following table gives the financial analysis of the different actors involved in the production and marketing of Holstein cow's milk.

Results in Table 6 show that the gross margin generated by small producers is 33,800 CFA francs. This margin is much lower than that found among small producers by [24] in Burkina Fasso which was 107,843 FCFA. The very low performance of milk production in the production systems of small producers results in the absence of an adequate policy to boost production in relation to the available resources and the economic environment, which has repercussions on the market milk.

Analysis of the operating account of the different models of actors involved in the production and marketing of milk in grassfields shows that this activity is profitable for all of these operators. However, the profit margins generated by large producers (278,500 F CFA / month) and small producers (33,800 F CFA / month) are the most interesting. The hypothesis that the production and marketing of Holstein milk in grassfields is a profitable income-generating activity is therefore accepted. Large producers get supplies from small producers at a rate of 300 FCFA per litter and resell them after processing at 1000 FCFA. This dairy income allows them to integrate the rotating savings and credits association.

3.3 Dairy Income Contribution to Improving the Living Standards of Dairy Farmers

The Chi square test of independence was conducted in order to explain the contribution of dairy income through rotating saving and credits association in improving the living standards of producers.

The results of the analysis showed that the rotating savings allow milk producers who belong to the rotating saving Associations to improve their standard of living. Thus, on the basis of the chi-square test of independence, we observed that $X^2 = 5.756$ and the probability (sig) = 1.6% which is less than5%, which implies that the result is significant at 5%. The null hypothesis is therefore rejected and the alternative hypothesis is accepted. Thus, dairy income through rotating savings and credits association significantly allow milk producers to improve their standard of living by financing of the production of milk in production units, the education of children in breeding households. Rotating savings and credits association facilitate access to household food and healthcare. Therefore milk producing households belonging to rotating saving Associations have an improved standard of living compared to those who did not integrate the rotating saving Association. These results are similar to those found by [13] on the contribution of rotating savings and credits association to financing the activities of dairy producers who have decided to set up as a rotating savings and credits association [25] in Jamaica on the contribution of dairy income to the expenditure of pastoral households.

Dairy income play a very important role in improving the living standards of milk producers. Thus the results show that in the study areas 88.31% of production managers are grouped into an Association and they practice the rotating savings. The largest producers (those who produce and transform) contribute 10,000 F per week and the small producers (those who produce and sell gross) contribute 3,000 F per week. These results are far superior to those found in Tanzania and Kenia by [26] which were 4.3% and 45% respectively. With the money from the rotating saving, they contribute to the education of their children, they feed themselves, they maintain themselves, and they build themselves. [26] even argues that tontines contribute 80% and 60% of total household expenditure in Tanzania and Kenia respectively.

Table 6. Small producers' operating account

Total costs		Total Revenu	
Items	**Value (FCFA)**	**Items**	**Valeur(FCFA)**
Cow care	2000	selling price of raw milk	45 000
Purchase of salt	2500		
Purchase of additional feed	14 000		
Veterinary	1500		
TC	**11 200**	**TR**	**45 000**
GM	**33 800**		

4. CONCLUSION

The objective of this study was to analyse the local production and marketing of milk from Holstein cows in the Grassfield (North-West and West regions of Cameroon) with regard to poverty reduction strategies in order to understand to what degree of Holstein contributes to the rural economy. For this purpose, descriptive statistics, financial analysis and the chi-square test of independence were carried out to show the contribution of Holstein breeding to improving conditions lives in rural areas. The results showed that these economic production and commercialisation activities take place under local conditions and are financially profitable. Thus the determination of the gross margins of the two actor categories showed that the large producers recorded a profit margin of 256,600 francs CFA / month and the small producers recorded a gross margin of 33,800 francs CFA / moth. The results also showed that the chi-square test of independence was significant at 5%, which means that rotating saving group significantly allow milk producers to improve their standard of living through the improvement of incomes. The evaluation of the contribution of rotating saving and credits association in improving the standard of living of households producing Holstein milk has shown that rotating saving and credits association contribute significantly to the financing of the production of milk in production units, the education of children in breeding households. Rotating saving groups facilitate access to household food and healthcare. These economic activities of production and commercialisation of milk from Holstein cows certainly makes it possible to meet the daily needs of households, but it remains an informal activity in view of the production environment.. Therefore In order to improve this sector of activity so that producers can continue to benefit from it, an adequate policy of stimulating production in relation to the available resources and the economic environment should be put in place in order to improve very poor milk production performance in production systems although production and marketing activities are currently impacted by the COVID-19 pandemic.

CONSENT

The 325 head of production units gave their verbal consent for the collection and publication of results for academic purposes only.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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