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Breeding Practices and Use of By-Products Derived from Mango and Cassava in Cattle and Sheep Fattening in Western Burkina Faso

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Abstract

Breeding and feeding practices were analyzed through field surveys of farmers in the Bobo-Dioulasso and Orodara areas. Fifty-four breeders identified with the support of technical services and breeders' organizations were interviewed on the socio-demographic characteristics of the breeder, information on the farm, the conduct of the breeding activity, economic parameters and the main constraints of the activity. Confirmation of a k-means classification result by Discriminant Factorial Analysis (DFA) enabled us to retain 35 farmers out of the 54 surveyed. Breeding practices have been classified into three categories: Class 1, made up mainly of cattle fatteners; Class 2, made up of sheep fatteners and dairy farmers; and Class 3, made up of farmers practicing fattening (cattle and sheep) and dairy production. Feeding methods were grazing + supplementation, practiced by 56.17% of breeders, and rationing, practiced by 43.83%. All farmers used roughage, concentrates and minerals at varying rates according to class. Concentrates were used more in Class 3. Mango by-products were used by a minority of farmers. Cassava peelings were mainly used by farmers in Class 3 (87.5%) and Class 2 (12.5%). The number of cattle fattened per rotation was higher in Class 1 (28 animals) than in Class 3 (15 animals). According to the majority of farmers interviewed, fattening is a profitable activity. The profit margin per animal was higher in Class 3 (112,154.49 XOF) than in Class 1 (93,463 XOF). Despite all this, livestock farming is faced with food, commercial, health and technical constraints that hamper its development in the Bobo-Dioulasso and Orodara zones.

Subject Areas

Breeding

Keywords

Breeding Practices, Mango Feed, Cassava Feed, Cattle and Sheep Fattening and Burkina Faso

1. Introduction

Livestock farming in West Africa, which is growing rapidly, accounts for 40% of Gross Domestic Product (GDP) and is a key economic activity for the population in general, and rural populations in particular [1] [2]. Livestock farming in Burkina Faso contributes more than 18% to GDP, 38% to the monetary income of rural households and provides livelihoods for 82% of these households [3]. The animal herd that forms the productive base is made up of various species (cattle, sheep, goats, donkeys, horses, pigs, poultry of all species, etc.) and, according to the figures reported by [4], includes more than 15,000,000 TLU (Tropical Livestock Unit) equivalents. This qualifies Burkina Faso as a livestock exporting country to neighboring coastal countries (Ghana, Côte d'Ivoire, Togo, Benin) [5]. Despite its importance as described above, livestock productivity in Burkina Faso faces numerous difficulties that limit production growth [6] to meet the strong and growing demand for animal products. Among these constraints, feed is cited as the main one, due to the low availability and high cost of feed, as well as frequent feed stock-outs [7]. What's more, livestock production systems that are still largely extensive and traditional, with feed based mainly on natural grazing, crop residues and agricultural and agro-industrial by-products, are not suitable for sufficient animal production for a population that exceeds 20 million [8]. Recourse to the intensification of animal production, in this case cattle and sheep fattening, appears to be a credible alternative to the growing demand for animal products for the population. In Burkina Faso, the practice of cattle and sheep fattening is a concrete example of meat production intensification [5] [8]. However, the development of good performance in this value chain is also confronted with the above-mentioned food constraint. Indeed, conventional feed, *i.e.* fodder from natural pastures harvested on site or mowed and preserved, harvest residues, SPA and SPAI, is no longer sufficient to satisfy the demand for feed for ordinary livestock farming and the running of fattening workshops. Feed is a key factor in the success of intensive fattening: [9] reported that it represents 71% to 74% of the cost of producing 01 kg of meat. Recently, [10] reported that in 3 localities in Cameroon, feed represented between 8.78% and 91.92% of production costs for intensive fattening of cattle over 5 head, demonstrating the influence of the rising cost of conventional feed on fattening production costs. Faced with this multifaceted feed constraint, research is turning towards alternatives based on non-conventional feed resources [11]. These include the use of *Faidherbia albida* pods [12], mango by-products [13] [14], cassava [15] and pineapple [16], with a view to increasing the availability of food resources and thus lowering production costs. Studies conducted by several authors [15] [17] [18] [19] have demonstrated the relevance of the rational use of rations incorporating these non-conventional feed resources in animal feed. In Burkina Faso, however, very few studies, apart from those by [8] and [20], have looked at the use of mango and cassava-derived feeds in the rationing of ruminants, particularly cattle and sheep for fattening. There is no information on the rational use of feeds incorporating mango and cassava by-products in the fattening of ruminant cattle and sheep. These feeds are reputed to be rich in energy, Crude Fiber and ADF and NDF fibers, and are well suited to ruminant feeding [13] [21] and [22]. The aim of the present study is to review cattle and sheep fattening practices, and farmers' knowledge of the existence of feed production technologies based on mango or cassava by-products and the use of these feeds in the rationing of cattle and sheep for fattening in the provinces of Houet and Kénédougou in Burkina Faso.

2. Material and Methods

2.1. Study Site

The study took place during the 3rd quarter of 2022 in the Houet and Kénédougou provinces of the Hauts-Bassins region of Burkina Faso (**Figure 1**). The geographical coordinates are 11˚19'60"N and 4˚15'0"W and 11˚25'00"N and 5˚00'00"W for Houet and Kénédougou respectively. The study area has a Sudanian-type climate with a 7 - 8 month (November to May) dry season, a 4 - 5 month (June to October) rainy season and an average annual rainfall of between 900 and 1,200 mm with average temperatures low compared with the rest of the country and varying between 22˚C and 34˚C [23]. The vegetation consists of wooded to shrubby savannahs, dry forests and gallery forests along watercourses [8]. The main socio-economic activities of the local population are agriculture and livestock breeding. Cattle and sheep fattening, once the preserve of agro-pastoralists and pastoralists, is now enjoying a boom with the emergence of new players (civil servants, retirees, private individuals, traders, etc. [24].

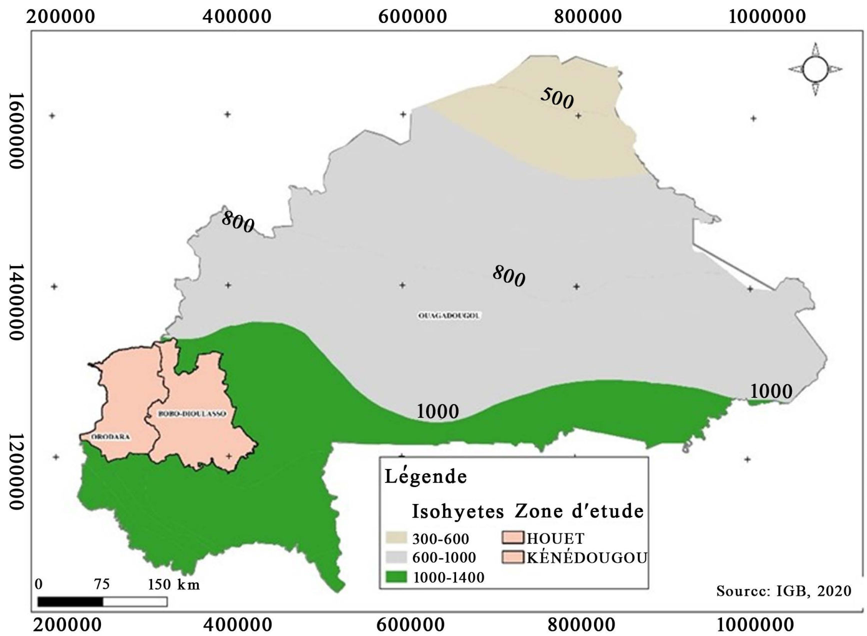

Figure 1. Study area location.

2.2. Method of Sampling and Data Collection

A cross-sectional survey of livestock breeders in the Bobo-Dioulasso and Orodara areas was carried out in order to provide a clear picture of breeding, feeding practices and the use of mango and manioc by-products. Based on a list provided by the deconcentrated technical services in charge of livestock, notably the Direction Régionale des Hauts-Bassins and the Directions Provinciales du Houet and du Kénédougou, the breeders were then contacted to explain the purpose of the study. Those who consented were retained for the administration of the questionnaire. A survey form was drawn up for this purpose. The data collected covered location, socio-demographic information, production and marketing activities, and constraints encountered in livestock farming. The survey consisted of formal one-pass surveys. The questionnaire was administered individually from June 04 to August 26, 2022. Initially, seventy (70) farmers were surveyed. In the end, a sample of fifty-four (54) breeders was surveyed. Many of the breeders contacted did not respond favorably to our request, despite the support of the Ministry's decentralized technical services in charge of animal resources.

2.3. Data Processing and Analysis

The data collected was coded, entered into Access and then transferred to the Excel spreadsheet. After processing, a sample of thirty-five (35) farmers out of the fifty-four (54) surveyed was retained for analysis. This was due to the fact that there were many aberrations in the information provided, or in some cases no information at all. Factor analyses were carried out to group the farms into homogeneous types or classes. A Principal Component Analysis (PCA) was first carried out, enabling the selection of classification variables on the basis of a proven minimum threshold of 75% of the cumulative variance of 75% on the 3rd factorial axis, a validation condition for the selected variables. A dynamic cluster analysis (K-means) was then performed and the classes obtained at this level confirmed by a discriminant factor analysis. This approach has already been used by (Kiendrébeogo, Mopaté, and Kaboré-Zoungrana 2014) to establish typologies of pig farms in Bobo-Dioulasso and Burkina Faso. Frequency calculations and analyses of variance (ANOVA) using the Fisher model (LSD) with a 5% threshold were used to characterize the farms according to the classes selected. The averages obtained by ANOVA were used to separate classes where necessary.

3. Results

3.1. Classification of Farms Surveyed

3.1.1. Descriptive Statistics for Farm Classification Variables

Table 1 shows the descriptive statistics of the variables used for classification. The results show that deviations from the mean for all variables, with the exception of animal value (VAL_AMX), are above average.

3.1.2. Classification of Farms Surveyed in the Houet and Kénédougou Regions

The analysis yielded the following results: Farm classes were significantly distinct according to the results of the one-way test of equality of class means (Table 2) and the value of the indices of the discriminant canonical functions (Table 3). The variables investment (INVEST), value of animals (VAL_AMX) and health costs (SANE_COU), expenditure on feed (ALIM_COU) and revenue from product sales (RECET_TOT) were highly discriminant ($p = 0.0001$). The variable RECET_TOT) was significantly discriminant ($p = 0.001$). The variable sum of expenses (DEPENS_TOT) was not discriminant.

Table 1. Descriptive statistics for classification variables.

Variable	N	Minimum	Maximum	Average	standard deviation
INVEST	35	30,000	17,500,000	1,367,701	3,551,714
VAL_AMX	35	225,000	17,000,000	4,411,000	4,216,966
ALIM_COU	35	5,000	15,000,000	1,836,279	2,686,717
SANTE_COU	35	-	970,000	123,057	179,574
DEPENS_TOT	35	448,000	49,020,000	7,826,743	9,312,958
RECET_TOT	35	1,800,000	142,500,000	15,306,730	25,123,081

INVEST = Investment, **VAL_AMX** = Animal value, **ALIM_COU** = Feed cost, **SANTE_COU** = Health cost, **DEPENS_TOT** = total production costs, RECET_TOT = Total revenue on sales.

Table 2. Unidimensional test for equality of class means.

Variable	Lambda	F	DDL1	DDL2	p-value
INVEST	0.044	349,891	2	32	<0.0001
VAL_AMX	0.300	37,362	2	32	<0.0001
ALIM_COU	0.626	9563	2	32	0.001
SANTE_COU	0.448	19,720	2	32	<0.0001
DEPENS_TOT			2	32	
RECET_TOT	0.626	9548	2	32	0.001

INVEST = Investment, **VAL_AMX** = Animal value, **ALIM_COU** = Feed cost, **SANTE_COU** = Health cost, **DEPENS_TOT** = total production costs, RECET_TOT = Total revenue on sales.

Table 3. Correlations between classification variables and factor axes and indices of discrimination functions as a function of factor axes.

Variables	Correlation Indices		Indices of canonical functions discrimination	
	F1	F2	F1	F2
INVEST	0.99	−0.059	1.288	−0.324
VAL_AMX	0.469	0.798	0.714	1.54
ALIM_COU	0.584	0.236	−1.218	−1.199
SANTE_COU	0.716	0.262	0.529	1.175
DEPENS_TOT	0.796	0.431	0	0
RECET_TOT	0.265	0.632	−0.652	−0.475

INVEST = Investment, **VAL_AMX** = Animal value, **ALIM_COU** = Feed cost, **SANTE_COU** = Health cost, **DEPENS_TOT** = total production costs, RECET_TOT = Total revenue on sales.

Two factorial axes (Tables 1-2, Figures 2-3) were formed at the end of the classification analysis. The cumulative variance of the two axes was 100%:

- The F1 factorial axis: the cumulative variance of this axis was 91.93%. It was positively correlated with all variables. It is the INVEST investment axis with the highest correlation (0.99) and discrimination (1.288) indices (Table 3).

- The F2 factorial axis: the cumulative variance of this axis is 8.07%. It is negatively correlated with the INVEST variable and positively correlated with all other variables. It is the axis of the VAL_AMX animal value, with the highest correlation (0.788) and discrimination (0.714) indices (Table 3).

Three breeding classes were found. Discriminant factor analysis (DFA) confirmed the formation of these classes at 100% without confusion. They were projected into the factorial space shown in Figure 3.

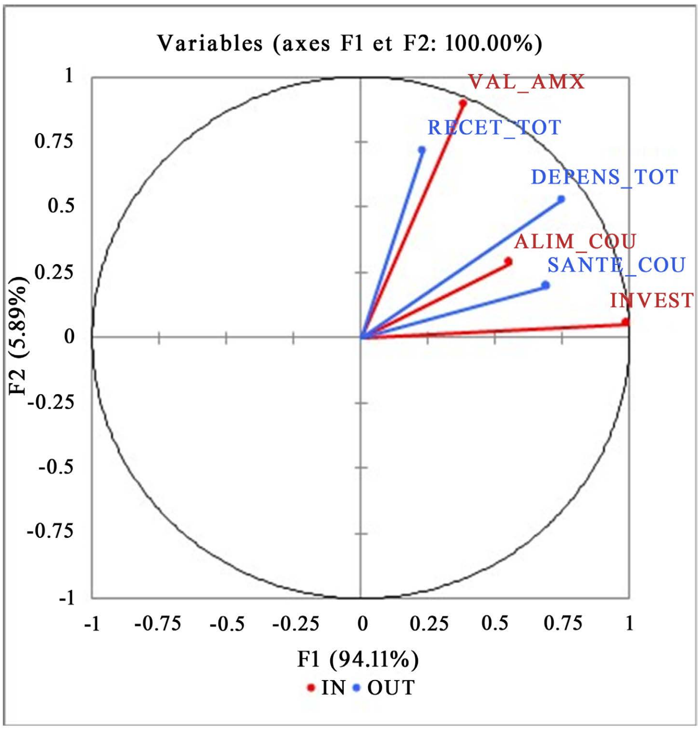

Figure 2. Correlations between variables.

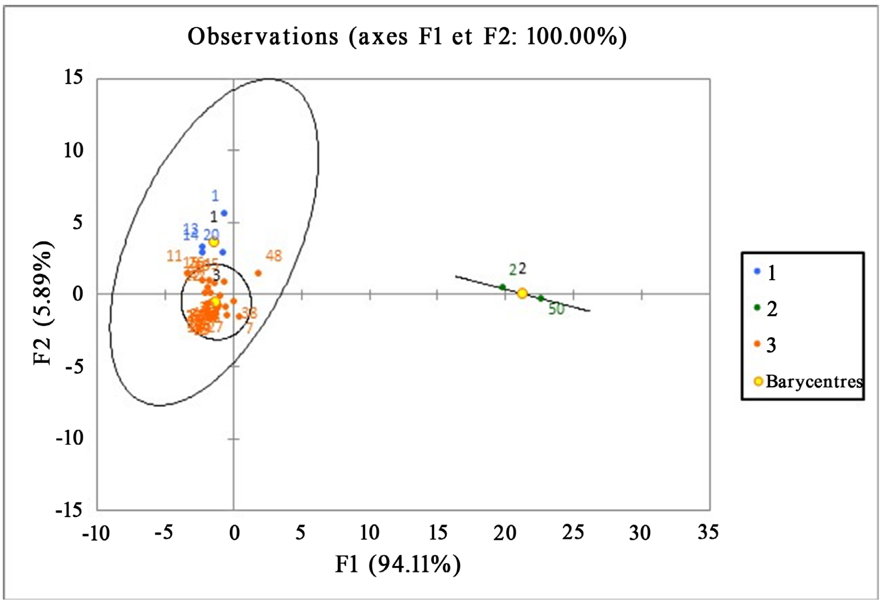

Figure 3. Projection of farms and farm classes in factorial.

- Class 1 made up of 6 farms/35 or 17.41% with class barycenter coordinates −0.025 and 3.783 along the respective F1 and F2 factorial axes;

- Class 2 made up of 02 farms (5.71%) with class center of gravity coordinates of 23.454 and −0.769 along the F1 and F2 factor axes respectively;

- Class 3 made up of 27 farms 77.14% of the farms with class barycenter coordinates of −1.732 and −0.784 along the F1 and F2 factor axes respectively.

Table 4. Characterization of farms by class.

Parameters		Farming Class			Sample (N = 35)
		1(n = 5)	2(n = 2)	3(n = 27)	
Location	Bobo-Dioulasso	14.3	5.7	42.9	62.86
	Orodara	2.9	0	34.2	37.14
Age	] 20; 39[	0	0	44.44	14.81
	] 40; 59[	83.3	100	55.56	79.63
	-> 60	16.7	0	0	5.56
Profession	Farmer	0	0	3.7	1.23
	Retailer	16.7	50	44.44	37.04
	Breeder	83.3	50	48.15	60.49
	Others	0	0	3.7	1.23
Education level	Literate	33.3	0	25.93	19.75
	Primary	0	50	11.11	20.37
	Secondary	50	0	11.11	20.37
Activity/order	Main	83.3	100	44.44	75.93
	Secondary	16.7	0	55.56	24.07

3.2. Socio-Demographic Characteristics of Surveyed Farmers

Table 4 shows the socio-demographic characteristics of the farms. The farms belonged to Classes 1 (6 farms or 17.14%), 2 (02 or 5.71%) and 3 (27 or 77.14%). All Class 2 farms and the largest proportion of Class 1 and 3 farms were located in Bobo-Dioulasso. The majority of breeders in all classes, and all Class 2 breeders, were between 40 and 60 years old. Breeding was the main activity, trade the secondary one. The 2 activities were practiced at the same level in Class 2. Farmers in Classes 1 and 2 were better educated than those in Class 3. Farmers had received technical support in Classes 1 (33.33% of them), 2 (50%) and 3 (29.63%). They received technical and financial support in Class 3 (3.7%) and were members of a breeders' organization in Classes 1 (33.33%) and 3 (14.81%).

3.3. Characteristics of Fattening Practices

Fodder farming has been practiced for less than 10 years in Class 3 by more farmers in Kénédougou than in Houet; between 10 and 30 years by the largest number of farmers in Classes 1 and 3, and half the farmers in Class 2.

- ***Statistical parameters of fattening practices***: Table 5 presents the statistical parameters of fattening practices. The average number of cattle fattened per year was significantly higher and lower from Class 1 and 2 to Class 3 ($p = 0.001$). The fattening cycle and number of rotations/years were homogeneous between classes (p > 0.05). The age of the animals at the start of the operation was over 3 years in all farm classes (See Table 6). The mean values for number of sheep fattened/year, fattening cycle, number of rotations/year and average age of sheep at start-up were homogeneous between breeding classes (p > 0.05). In absolute terms, the age of sheep at start-up was 2 years in Classes 1 and 3, and less than 18 months in Class 2.

- ***Types of production***: Figure 4 shows the types of production practiced by breeders in the different classes. Farmers in Classes 1 and 3 practiced both cattle and sheep fattening. Some Class 2 and 3 farmers practiced both cattle and sheep fattening. Breeders in Class 3 practiced both fattening and dairy production.
- ***Breeds/varieties of cattle used for fattening***: The results presented in Figures 5-6 show that the Zebu Peul breed was the most widely used by farmers for fattening, across all breeding classes. The Goudali breed was used by over 10% of breeders overall. The Goudali, mixed and bull breeds were each used by less than 10% of breeders in each Class. Class 3 used the largest number of breeds/varieties.

3.4. Habitat and Equipment

The habitat of the animals in the different classes consisted of:

- ***Class* 1**: stable for 16.67% of breeders, pen (50%) and pen + shed (33.33%).

- ***Class* 2**: pen + shed.

- ***Class* 3**: pen + shed (59.26%), pen (33.33%) and barn (7.41%).

Feeding troughs and drinking troughs were made of fixed masonry or metal half-barrels, or of used bowls or buckets. Other infrastructure, materials and equipment, such as drilling rigs, vehicles, carts, wheelbarrows, rakes, shovels, straw choppers and sickles, were used to run the farm.

3.5. Husbandry and Feeding Practices for Fattening Animals and Use of Mango and Cassava By-Product Feeds

- **Feeding practices:** Fattening animals were put out to pasture and then kept in stalls to be supplemented with agro-industrial by-products (SPAI) in breeding Classes 1 (66.7% of breeders), 2 (50%) and 3 (51.9%). They are kept in complete stalls to receive rationed feed in breeding Classes 1 (33.3%), 2 (50%) and 3 (48.1%). Overall, 56.2% of breeders practiced guarding + stabling + supplementation, and 43.8% total stabling during the fattening period.
- **Feed distributed:** Figure 7 shows the main ingredients used to feed the animals. For each class, cottonseed cake, cereal bran, legume haulms and cereal straws were the main feed resources. The most widely used concentrates were cottonseed, cotton hulls, milling bran and cotton cake. Minerals, mainly salt, were used by farmers in Classes 1 and 3. Some farmers use fresh mango to feed their animals, but lack the technology to transform its by-products into feed. Farmers (25.31%) in Classes 2 and 3 all used cassava peelings to feed their animals.

Table 5. Experience in fattening activities.

Year groups	Farming Class						Sample
	1		2		3		
	Houet	Kénédougou	Houet	Kénédougou	Houet	Kénédougou	
]0 ; 10[	-	-	-	-	33.3	50.0	40.5
]10 ; 30[	100	100	50	-	66.7	33.3	54.8
>30	-	-	50	-	-	16.7	4.8
Total	100	100	100	0	100	100	100

Table 6. Typical fattening operation statistics.

Paramèters		Farming Class			Pr > F	Significant
		1	2	3		
Cattles	Mouthfuls/year	110b	91ab	28a	0.001	Oui
	Fattening cycle	3.3a	4a	4.4a	0.194	Non
	Rotations/year	2.9a	2.9a	2.3a	0.542	Non
	Age at start	58.9ab	54.9ab	45.5a	0.116	Non
Sheeps	Mouthfuls/year	-	58.9a	22.7a	0.426	Non
	Fattening cycle	-	3a	3.4a	0.178	Non
	Rotations/year	-	3a	2.9a	0.466	Non
	Age at start	-	17.6a	24.9a	0.153	Non

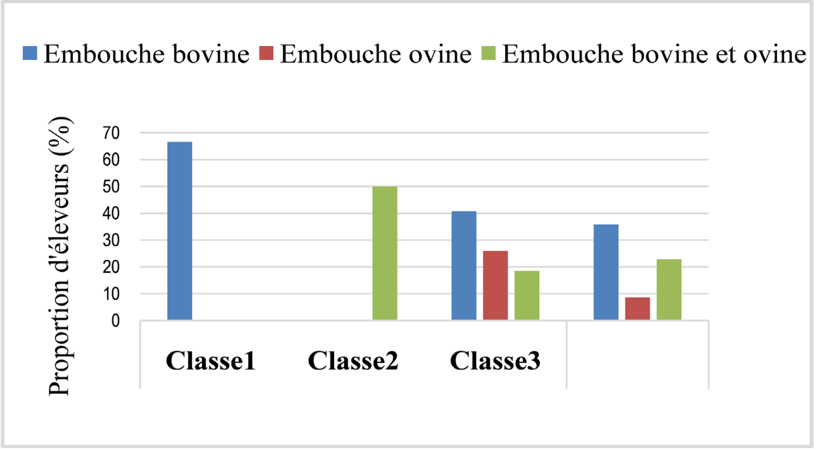

Figure 4. Types of fodder in the different breeding classes.

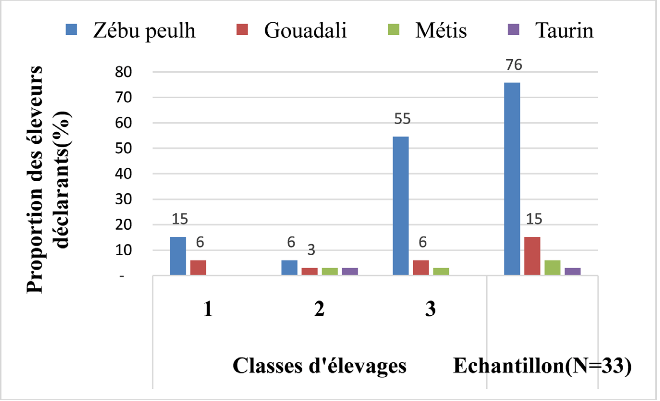

Figure 5. Cattle breeds fattenedby percentage of reporting breeders.

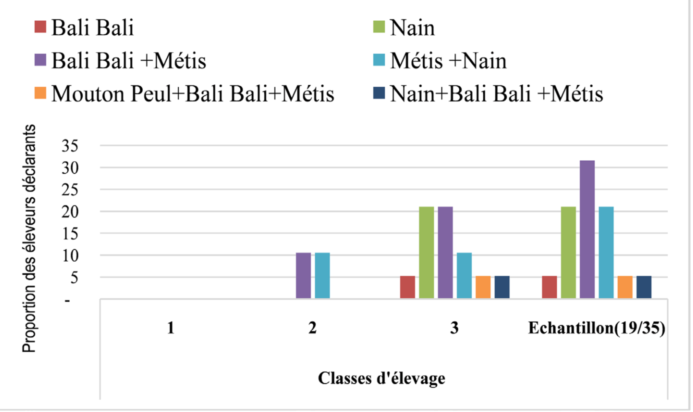

Figure 6. Sheep breeds fattened by percentage of declaring breeders.

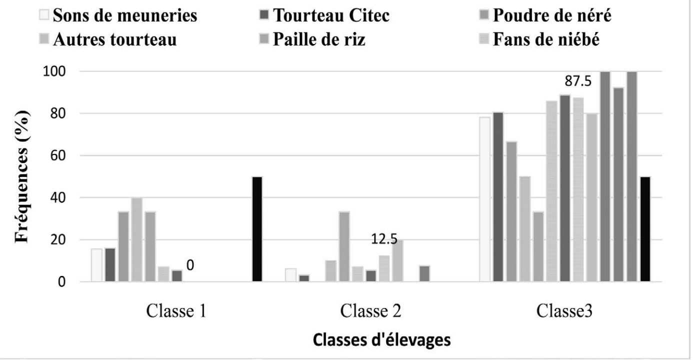

Figure 7. Main ingredients used in feed for fattening animals.

3.6. Health Monitoring of Stuffed Animals

Table 7 shows the prevalence of diseases in the study area according to the farmers surveyed, as well as their response to these diseases. The major pathologies encountered were animal trypanosomes, foot-and-mouth disease, diarrhoea and brucellosis. In the event of disease, farmers most often consulted a veterinarian, or self-medicated with veterinary care. All farmers claimed to practice medical prophylaxis, but sanitary prophylaxis (hygiene of clothing and equipment/materials) was practiced by 49.66% of them.

Table 7. Typical fattening operation statistics.

Variables	Farming Class			Sample (%)
	Class 1	Class 2	Class 3	
Main pathologies				
-Trypanosome	5455	100	4909	6788
-Foot and mouth disease	1818	0	2727	1515
-Brucellosis	909	0	909	606
-Diarrhea	1818	0	1455	1091
Animal health monitoring				
-Technician	1667	0	1111	926
-Self-medication	8333	100	8889	9074
Prophylaxis practice				
-Sanitary	1667	0	5556	2408
-Medical	100	100	8519	9506

3.7. Main Constraints on Fattening Activities

Figure 8 shows the main constraints to the practice of fattening declared by the farmers surveyed in the Bobo-Dioulasso and Orodara zones.

Feeding, in terms of soaring prices and unavailability of ingredients, and reduced grazing space, aggravated by the insecurity of herdsmen, is the main constraint cited by breeders of all classes. Next comes the health constraint, in which emerging diseases not yet under control are responsible for animal mortality. The financial constraint, due to difficult access to credit, high taxes and lack of financial means, comes third.

3.8. Technical and Economic Performance of Fattening Practices

Table 8 shows the production parameters and the operating account. The average number of cattle per rotation and the initial age of cattle entering fattening were significantly higher in Class 1. On the other hand, the average length of rotation was higher in Class 3. In sheep fattening, the average number per rotation, initial age of entry into fattening and duration of rotation were 11 head, 111.3 days and 24 months respectively. Apart from the cost of acquiring animals, feed-related expenses were the highest for all breeding classes, and differed from one class to another. The result is a statically identical profit margin between Class 1 and Class 3 for cattle fattening. Estimation of the average income from the profit margin and the number of animals per rotation, gave per head of cattle 93463.63 and 112154.497 F CFA for Classes 1 and 3 respectively, and 49620.55 F CFA per head of sheep fattened.

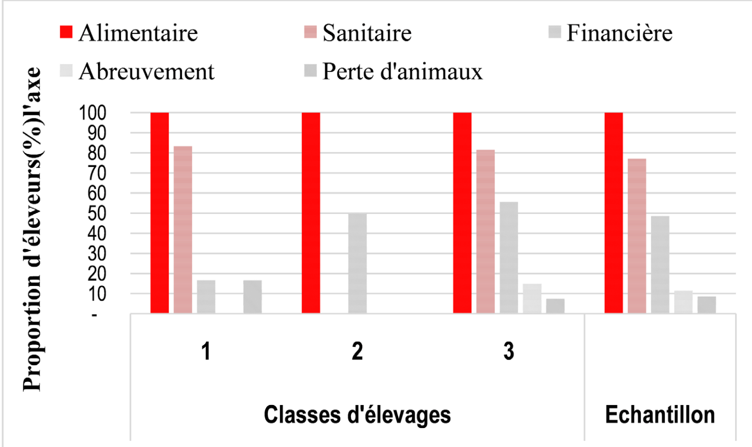

Figure 8. Main constraints of the fattening activity in the area of Bobo-Dioulasso and Orodara areas.

Table 8. Technical and economic parameters of fattening practices.

Variables	Farming Class	
	1	3
--------------------------------Cattle fattening--------------------------------		
INVEST	777,286a	288,155a
VAL_AMX	8,303,688a	3,395,437b
ALIM_COU	2,141,765a	1,575,995a
SANTE_COU	113,037a	121,238a
MOS_COU	384,044a	279,604a
DEPENS_TOT	11,563,731a	5,625,256b
RECET_TOT	20,450,862a	9,198,601b
Result	8,664,070a	3,574,377a
Gross income/rotation	2,616,984a	1,682,325a
Gross income/animal	93,464a	112,154a
--------------------------------Sheep fattening--------------------------------		
INVEST		207,143
VAL_AMX		1,664,286
ALIM_COU		605,929
SANTE_COU		36,857
MOS_COU		560,000
DEPENS_TOT		2 676 000
RECET_TOT		4,469,429

Continued

Result	1,793,429
Gross income/rotation	545,826
Gross income/animal	49,621

INVEST = Investment, **VAL_AMX** = Animal value, **ALIM_COU** = Feed cost, **SANTE_COU** = Health cost, **DEPENS_TOT** = total production costs, RECET_TOT = Total revenue on sales.

4. Discussion

4.1. Socio-Demographic Characteristics of Farms in the Study Area

Our results show that the majority of breeders in all classes, and all Class 2 breeders, were between 40 and 60 years of age. All Class 2 breeders, over 80% of Class 1 breeders and over 50% of Class 3 breeders were in this age bracket. The importance of this age group could be explained by the fact that the livestock activity, in this case fattening, is practiced by mature and responsible players, making it an income-generating activity. Experience in the Activity is the same trend and further explains the role played in the maturity of fatteners to take risky decisions. These results corroborate those of [8] who reported from a study conducted in the western part of Burkina Faso that fattening was practiced mainly by actors aged over 30. Maturity and proven experience may, moreover, explain the scale of investment in production represented by the total expenditure (Table 5) of Class 1 fatteners, which was significantly different and represented more than 2 times the value of the expenditure of Class 3, which practiced the same type of fattening. The high level of involvement of breeders and traders in the breeding activity in all classes proves that the activity constitutes a source of income generation. Several socio-professional strata were involved in fattening. Most of the breeders surveyed were livestock export traders. The same observations were made by [25] who state that intensive fatteners are mostly livestock export traders who sell animals fattened and/or purchased outside Burkina Faso (Côte d'Ivoire, Nigeria) at more remunerative prices. Classes 1 and 2 breeders were almost all located in Bobo-Dioulasso, which would explain why they were better educated than those in Class 3, spread between Bobo-Dioulasso and Orodara. The same observation had been made in the departments of Ouémé and Plateau in Benin by [26] and in the Mono and Couffo departments in Benin by [27]. The greater representation of breeders of all classes in the Bobo-Dioulasso area can be explained by the ease of supply of production inputs and the proximity of the big city, which is a potential permanent market where fatteners also sell fattened animals.

4.2. Main Characteristics of Fattening Farm Classes

The descriptive statistics of the quantitative variables used for the classification analyses revealed a wide disparity between the levels of the farms in terms of deviations, all of which were greater than the mean excluding the value of the animals (VAL_AMX), indicating a wide dispersion of farms in terms of the deviations of the averages calculated. The grouping of farms into 3 significantly distinct Classes 1, 2 and 3 (**Figure 2**) (**Table 2**) justifies the need, after the analyses, for classes of farms with homogeneous intra-class characteristics and different intra-class characteristics for certain characteristic variables. This is borne out by the results of the one-way test of class averages, which showed a high degree of discrimination between classes for all variables apart from animal value. Factor analyses of this type have already been used by other authors in typologies of pig farms in various agro-climatic zones in Burkina Faso, [28] [29] and fattening practices in Burkina Faso [8]. The dominance of the F1 factorial axis with 91.07% of the variance explained, which is also correlated with all the classification variables, proves that the levels of investment in production factors represented by these variables and others not involved in the classification analyses are heterogeneous. Disregarding dairy production, which is practised only in Class 2, which is not 17 parts of the objectives of the investigation, we note that fattening is practised by farmers in all classes. However, there is a progressive specialization from Class 3, where all types of production are present, and Class 2, where only the mixed type of production (beef + sheep fattening) is present, to Class 1, where only beef fattening is practiced. The presence of animal breeds with proven butchery performance, such as mixed breeds and the Goudali breed for cattle, and mixed breeds and the Bali-Bali breed for sheep, indicates the quest for greater productivity in the fattening activity. The differentiation is clearly seen in the number of animals fattened per year, where the results show that Classes 1 and 2 farmers fattened significantly more cattle than Class 3 farmers, and Class 2 farmers fattened 2 ½ times as many sheep as Class 3 farmers (**Table 5**). In the production process, the use of labor differed between breeding classes. All classes used family labor for production. Classes 1 and 3 also used hired labor. In terms of cattle fattening, these last 2 classes differ significantly in terms of the number of animals fattened per year, which for Class 1 is almost 4 times that of Class 3, while the other characteristics (number of rotations/year, rotation cycle, age of animals at the start of fattening) are virtually similar. Ultimately, the production account shows that Class 1 farms spent more and earned more income than Class 3 farms, but did not earn more per rotation and per animal than the latter. Examination of financial performance In sum, and taking into consideration the coordinates of the barycenters of the established farm classes and their projection in space, and the fact that the factoring axis concentrates almost all the cumulative variance, we can conclude that not only are the farms not at the same level, but they are also on a trajectory of intensification from Classes 1 and 2 towards Class 3. Typological classifications of pig farms [28] [29] and fattening cattle and sheep [8] reveal a gradual intensification of livestock production in the peri-urban areas of certain towns in Burkina Faso for monogastric livestock, and in western Burkina Faso for cattle and sheep fattening. As fattening is by definition an intensive breeding practice [30] we can affirm that the classification of farms was justified and that Classes 1, 2 and 3 represent groups of intensive farms, with gradual levels from Classes 1 and 2 to Class 3.

4.3. Feeding Practices and Use of Mango and Cassava By-Products in Fattening

Feeding practices were similar. Grazing + supplementation were the dominant feeding method. However, almost 15% more Class 3 farmers than Class 1 kept their animals in permanent stalls to provide them with rationed feed. Apart from fodder, various other resources were used by farmers to supplement animal feed. These were mainly coarse feeds made up of crop residues (rice straw, groundnut and cowpea tops), concentrates, notably agro-industrial by-products (cotton cake, cotton hulls, cotton seed, draff, milling bran), agricultural by-products (cassava, potato and mango peelings) and minerals (cooking salt). The use of an ingredient to feed animals is explained by its availability and affordability to farmers. The combination of three types of feed resources (roughage, concentrates and minerals) and their systematic use by farmers shows that they are aware that rapid weight gain depends on adequate feeding. The systematic use of all feed resources by class 3 breeders could be explained by their quest for rapid weight gain. The same observations have been reported by [8]. Agro-industrial by-products are generally used to supplement roughage, which is deficient in certain nutrients, especially in the dry season. The same observations were made by [31] who mentioned the importance of agro-industrial by-products as supplements in animal feed. Unlike mango by-products, whose use is not mentioned in any Class, cassava peelings are used in Class 2 and 3 in fattening practice with a frequency 6 times higher in Class 3. Overall, in relation to the use of these two non-conventional food sources, we can conclude that there is no use of mango by-products and little non-rational use of cassava peelings. However, some authors [8] et [13] reported direct harvesting of fresh mangoes that had fallen under orchards, or of processing by-products thrown into the wild or into dumps by animals on their foraging trajectory. This conclusion is in line with the findings of [32] who reported that mango and cassava by-products are available in Burkina Faso but are little or not used in animal feed. The use of cassava peelings by some class 2 and 3 breeders can be explained by their availability, but also by their accessibility to breeders. Indeed, cassava peelings were mainly used by farmers in Orodara, an area with many cassava processing units. In addition to this, the results of certain studies on the use of cassava peelings [33] [34] et [35] may have positively influenced the use of cassava peelings in animal feed, unlike mango by-products. Other authors [32] point out that mango by-products are not only available, but are also sources of nitrogenous matter and energy that could be made available through their transformation into feed for cattle and sheep fattening. During the dry season, when grasses and other forage grasses become scarce in rangelands, these local resources can correct the quantitative and qualitative imbalance in ruminant rations [36], especially for fattening animals. What's more, several studies have shown that their use in animal feed would improve zootechnical production performance while reducing ration costs and food production costs per live kg (CAPkgV) in monogastric pigs and poultry [11] [37] [38] [39]. The low use of by-products derived from mango and cassava could be explained by the fact that they are considered in Burkina Faso as non-conventional food resources, but also by the fact that there is little or no information on their availability and rational use as a feed resource for animals.

4.4. Feeding Practices and Technical-Economic Performance

The classes used in this study consider the feeding system, housing and herding, as well as the size of the farm. For cattle fattening, we note the predominance of Class 3 breeders (>50%), practiced essentially by breeders and traders. These farmers use the youngest animals, which they fatten over a relatively long period (>4 months), with less than 50 head/year. Farmers in Class 1 (>100 head/year) are essentially breeders and traders. In this class, breeders use older animals (>50 months) in a relatively shorter time (<4 months). Breeders in Class 2 (>10%) practiced by breeders and traders (<50 head/year) with older animals (>50 months) in a shorter time than those in Class 3. These results show that Classes 1 and 3 farmers are involved in intensive production. It is reported that farms with more than 50 head are considered intensive producers [8]. Sheep fattening was practiced mainly by Class 3 breeders and traders (<50 head/year) with aged animals (>24 months) in a relatively short cycle (<4 months). Class 2 breeders and traders practiced sheep fattening with large numbers (≥50 head), younger animals (<20 months) and in a relatively short time (3 months). Those in Class 1 practiced fattening with older animals (<20 head/year) in a long cycle (<4 months). These results show that sheep fattening is a source of economic income for Class 3 farmers. Authors such as [40] have noted the existence of three groups of sheep fatteners in southern Benin. On the other hand [8] reported two sheep fattening groups in a study conducted in Burkina Faso. The strong involvement of breeders and traders in the breeding activity shows that this activity constitutes an important economic source and a means of investment for practitioners. The duration of cattle fattening observed in Class 1 was less than that of Class 3, but almost similar to that reported by the Ministry at national level, which is 110 to 120 days [41]. Other authors such as [8] reported 90 to 118 days and [42] reported 90 days as the average duration observed in Niger. However, the 127-day duration observed in Class 3 is much higher. In sheep fattening, the average number of animals fattened per rotation was in the 9 to 19 range reported by [8]. As for duration, it was less than the 4 and 5 months reported by the same authors, but within the range of the standard defined by INRAN, according to which the duration of fattening is 3 to 4 months for intensive fattening and 3 to 6 months for semi-intensive fattening [43]. The lack of precise data on the various costs of fattening units has prevented us from calculating net profits. However, the majority of fatteners surveyed claimed to make a profit. Analysis of the operating account shows that fattening is a profitable activity, and gross income was highest in Class 3. The variation in gross margin between Class 1 and 3 can be explained by the differences observed in production costs (purchase of animals, feed, health and miscellaneous expenses). The same observations were made by [44] in a study conducted in China. Feeding costs were the most important expense apart from the cost of purchasing animals. The same observations were made by [45] in a study conducted in Algeria. Feeding costs were the most important expense apart from the cost of purchasing animals. The same observations were made by [24] had reported a gross income of 45,000 XOF per cattle fattened in the Sahel and eastern zones of Burkina Faso, [8] a gross income of between 50,000 XOF and 66,000 XOF in semi-intensive fattening and the [46] a net margin of 109,479 XOF in semi-intensive and intensive fattening. On the other hand, it was lower than the 150,000 XOF and 348,173 XOF reported respectively by [8] in intensive fattening in Burkina Faso and [45] for intensive fattening in Algeria. These differences could be explained by the fact that the majority of fatteners had benefited from project support in the [8] study, *which* would have reduced farm expenses thus improving the productivity and profitability of fattening units. Our gross margin for sheep fattening of 93,464 XOF was well above the margins of 7565 XOF and 9580 XOF obtained by [8], in a study conducted in 2 villages in Mali, and the 26,914 XOF reported by [47] in a study conducted in 2 villages in Mali, and the 26,914 FCFA reported by [48] in Burkina Faso. However, our results could be revised upwards in the absence of any production constraints. Indeed, it should be noted that in all breeding classes, feed and health are cited by breeders as major production constraints, which has a negative impact on weight gain performance and ultimately on financial gain.

5. Conclusion

The study revealed three classes of livestock farmers in the Bobo-Dioulasso and Orodara areas, with cattle fattening predominating in Class 1, cattle and sheep fattening in Class 2, and all types of fattening in Class 3, practiced mainly by livestock farmers and traders. These classes are based on the intensive livestock production systems conferred by fattening, with a 20 evolutionary dynamic from Classes 3 and 2 to Class 1. During the fattening period, feeding takes a rational approach, with the use of concentrates and agro-industrial by-products in addition to roughage. We found that cassava processing by-products, in the case peelings, were little used in Classes 2 and 3 alone, and that mango by-products were not used at all. Agricultural by-products were used by livestock farmers to feed their animals. The fattening activity was profitable, with a higher profit margin for Class 3 fatteners, who nevertheless invested less than those in Classes

1 and 2. The use of mango and cassava by-products, which are abundant in the Orodara and Bobo-Dioulasso areas of western Burkina Faso, would help to reduce food and health constraints and production costs in fattening, and improve zoo technical performance and financial results. Demonstration tests on the rationing of fattening animals should be carried out to encourage the adoption of the use of mango and cassava by-products in livestock feed in general, and in fattening in particular.

Conflicts of Interest

The authors declare no conflicts of interest.

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