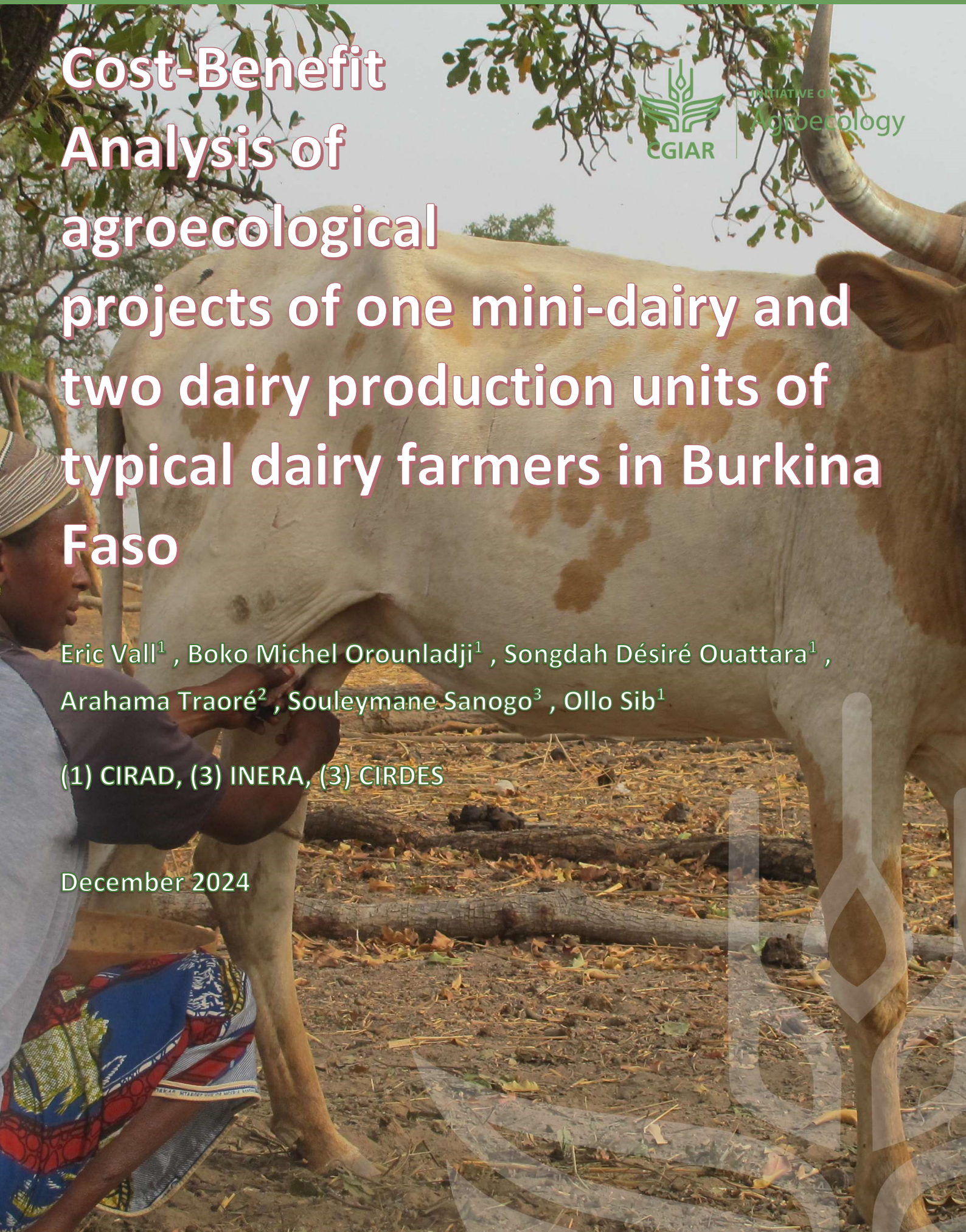

Cost-Benefit Analysis of agroecological projects of one mini-dairy and two dairy production units of typical dairy farmers in Burkina Faso

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Introduction

In Burkina Faso, consumption of dairy products is low (around 20 kg/capita/year). However, consumption is increasing and will continue to do so in the years to come, as the population and its purchasing power grow. There is an emerging demand for dairy products made from local milk. More and more consumers want to consume good-quality dairy products made from fresh milk, in various forms (liquid milk, yoghurts in various flavors, dêguê, gapal, cheese, butter, etc.). However, competition with dairy products made from low-cost imported milk powder is fierce. This is why the actors of the dairy value chain need to innovate at all levels of the agri-food chain to meet this emerging demand in the long term.

In this country the Agroecology Initiative (AEI) project, focused on the dairy value chain and conducted activities within an Agroecological Living Landscape (ALL) framework. This ALL is based on the Dairy Innovation Platform (DIPO, Plateforme d'Innovation Laitière multi-acteurs de Bobo-Dioulasso or PIL in french) established in 2020, to which new members joined in 2023 to form an ALL.

Co-designing an Agroecological Business Model for the dairy value chain is a significant objective of the AEI project in Burkina Faso. This work is being carried out mainly within the WP3 of the AEI "*Developing an inclusive economic model and financial strategies adapted to the Bobo-Dioulasso milk value chain*".

This document presents a quantitative cost-benefit analysis (CBA) concerning the integration of an agroecological technologie (named agroecologival packages) among three typical actors of the Bobo-Dioulasso dairy value chain, namely:

- The dairy production unit of an average agropastoralist dairy farmer
- The dairy production unit of an average mini-dairy farm
- A mini-dairy using mainly local milk

The general characteristics of these 3 types of actor are described by Sib et al. (2023).

The CBA follows the guidelines presented in the practical guide proposed by the WP3 coordinators (Narjes et al., 2024).

Method

CBA principles and indicators

CBA involves comparing two situations:

- Status Quo (ie: without AE package)
- Agroecological uprading (ie: with AE package)

The CBA considers the first 5 years of the AE package's implementation, plus the year of preparation (year 0) (Figure 1).

Discount rate r 6%	Status Quo			Agroecological upgrading		
Year (t)	Benefits cashflow (B_t)	Costs cashflow (C_t)	Discounted Net Benefit $(B_t - C_t) \times (1+r)^{-t}$	Benefits cashflow (B_t)	Costs cashflow (C_t)	Discounted Net Benefit $(B_t - C_t) \times (1+r)^{-t}$
0	$0.00	$200.00	-$200.00	$0.00	$500.00	-$500.00
1	$100.00	$200.00	-$94.34	$100.00	$500.00	-$377.36
2	$300.00	$0.00	$267.00	$200.00	$0.00	$178.00
3	$500.00	$0.00	$419.81	$300.00	$0.00	$251.89
4	$500.00	$0.00	$396.05	$1,000.00	$0.00	$792.09
5	$400.00	$0.00	$298.90	$1,000.00	$0.00	$747.26
Net Present Value	$NPV = \sum_{t=0}^{T} (B_t - C_t) \times (1+r)^{-t}$		$1,087.42	$NPV = \sum_{t=0}^{T} (B_t - C_t) \times (1+r)^{-t}$		$1,091.88
IRR	$NPV = 0 = \sum_{t=0}^{T} (B_t - C_t) \times (1+r)^{-t}$		77.84%	$NPV = 0 = \sum_{t=0}^{T} (B_t - C_t) \times (1+r)^{-t}$		32.99%
Present Value of cashflows	$\sum_{t=0}^{T} (B_t) \times (1+r)^{-t}$	$\sum_{t=0}^{T} (C_t) \times (1+r)^{-t}$		$\sum_{t=0}^{T} (B_t) \times (1+r)^{-t}$	$\sum_{t=0}^{T} (C_t) \times (1+r)^{-t}$	
	$1,476.10	$388.68		$2,063.58	$971.70	
BCR	$BCR = \sum_{t=0}^{T} (B_t) \times (1+r)^{-t} \Big/ \sum_{t=0}^{T} (C_t) \times (1+r)^{-t}$		3.80	$BCR = \sum_{t=0}^{T} (B_t) \times (1+r)^{-t} \Big/ \sum_{t=0}^{T} (C_t) \times (1+r)^{-t}$		2.12

Figure legend :

- r (discount rate): The discount rate is an interest rate used on the money market, for short-term loans. For this CBA analysis, the discount rate (r) used is 6%.
- NPV: Net Present Value of the project
- IRR (Internal Rates of Return): this is the value of the discount rate (r) that makes the NPV equal to zero. If r (IRR) > r, the project is more profitable than if the money were placed in the bank at rate r.
- BCR (Benefit-Cost Ratio): The BCR gives a rough idea of project viability and is associated with the following rule of thumb:

.1. BCR > 1: the project should generate positive NPV and have an IRR higher than the chosen discount rate. The higher the BCR, the better the investment.

.2. BCR = 1: suggests that the project's benefits equal its costs.

.3. BCR < 1: project costs exceed benefits (project not viable)

Figure 1. Principles and calculation methods for CBA indicators (Narjes et al., 2024)

Types of costs and benefits considered in the CBA analysis

In the CBA, costs and benefits are inventoried according to the categories presented in the tables below (Table 1 and Table 2). In this study, we have mainly considered direct costs and the increase in sales and revenues. In this report, Costs and Benefits are sometimes expressed in FCFA and sometimes in USD (the exchange rate used is as follows: 1 USD = 592.04 USD).

Table 1. Cost inventory template

Cost types	Status quo	AE upgrading
Direct costs such as labor directly involved in agricultural production, inputs, harvest and post-harvest expenses, manufacturing, etc. Including labor costs is important, even if it's just family labor. Although it doesn't affect cash flow, it's usually one of the biggest costs on small farms.... The daily wage in the region can be used as the family labor cost, but you can also modify it or use other values and justify this selection (as generally unemployment, age of farmers, etc., affect farmers' labor options).		
Indirect costs, which include electricity, utilities, management overheads, rent, utilities, etc.		
Intangible costs can be identified but not easily quantified or estimated, such as reduced employee morale due to a major change, loss of customers and/or brand value, reduced productivity and/or delivery times, etc.		
Opportunity costs arising from not exploiting other investment opportunities I suggest including the opportunity costs of land as a fixed cost, as land is generally one of the limiting factors and farmers' most valuable assets. You can use a land rental price for comparable uses in the region as a parameter.		
Potential risk costs such as those arising from regulatory risks, competition and potential environmental impacts		

Source: Narjes et al., 2024

Table 2. Benefits inventory template

Types of benefits	Status quo	AE upgrading
Increased sales and revenues through increased production and/or new products.		
Intangible benefits include the greater inclusion of disadvantaged members of the community in employment opportunities and increased customer satisfaction due to a safer, more diversified, and/or more nutritious food supply.		
Competitive advantage or increased market share		

Source: Narjes et al., 2024

Characterization of the dairy production unit of an average agropastoralist dairy farmer according to the Status Quo and AE Upgraded scenarios

We have considered that the farm of an "average" agropastoralist dairy farmer is made up of 3 production units: the extensive livestock production unit (from which the zebu cows destined for the milk production unit are taken), a crop production unit (5 ha) intended mainly for the household's consumption and for the sale of surplus grain (a production unit from which the agropastoralist takes fodder co-products to feed the animals of the dairy production unit) and finally the dairy production unit itself, which is the subject of this cost-benefit analysis.

The milk production unit in our simulation is based on a zebu sire and 10 adult zebu cows selected from the agropastoralist's herd (extensive livestock production unit).

Reproduction is by natural mating.

The typical trajectory of an animal born in this production unit is as follows:

- Females: Mature female => Calf (1 year old) => Heifer (2 years old) => Heifer (3 years old) / service => Mature milking female (+ calf/zebu calf)
- Males: Adult female => Calf (1 year old) => Bull (2 years old) => Bull (3 years old) => Sale

The basic feed is provided by grazing on natural pastures, which covers 60% of the biomass ingested (at a rate of 6.25 kgDM/d/TLU Tropical Livestock Unit ie an animal weighing 250 kg).

Veterinary care was estimated at 7,000 Fcfa/TLU per year, with a reduction of 25% in the AE Upgraded scenario due to better breeding conditions (more balanced diet, better habitat, better water quality).

Personnel: 1 shepherd and 1 farmhand paid 15,000 FCFA/month in the 2 scenarios.

Taxes: minimal (10,000 FCFA/year) in both scenarios.

Fluids and energy: only fuel to run the motorcycle at 2,000 FCFA/year/TLU.

The parameters used for the agropastoral dairy unit are presented in Appendix 1 and Appendix 2.

Box 1: The "Agroecological milk production" package

This package mainly mobilizes the following three agroecological principles (according to the terminology proposed by Wezel et al. 2020): recycling (of crop and livestock co-products into fodder and manure), synergies (farm-livestock interactions), input reduction (cattle feed replaced/substituted by fodder, mineral fertilizers replaced/substituted by manure). In practice, it boils down to the introduction of the following practices in the dairy production unit:

- Production of high-quality fodder to replace coarse fodder (cereal straw).
- Reasoned use of animal feed
- Organic fertilizer as a strong substitute for mineral fertilizers
- Integrated management of plant and animal by-products
- Balanced ration for dairy cows at an acceptable cost
- Use of medicinal plants to replace veterinary drugs (when effective)
- Optimal management of livestock and natural resources

The main characteristics and differences between the Status Quo and AE Upgraded scenarios for the agropastoralist's dairy farm are presented in Table 3. Table 3.

Table 3. Characteristics of the Status Quo and AE Upgraded scenarios for the agropastoralist's dairy production unit

	Status Quo	AE Upgraded
Mating success rate	50%	60% (improved due to better breeding conditions)
Equipment	Single park Sump	Improved park Bored well (clearer water) Manure pit
Crop rotation	Cultivated area: 5 ha No forage crops Cereal 90% Leguminous plants 10% of the total	Cultivated area: 5 ha Introduction of forage crops (10% in year 1 to 50% in year 5) Instead of cereals
Power supply	Rangeland (covers 60% of livestock biomass requirements) Forages, mainly cereal straw Top-up purchase of concentrates and quality forages	Rangeland (covers 60% of livestock biomass requirements) Reinforced with quality forage Top-up purchase of concentrates and quality forages
Health	Conventional prophylaxis	Use of herbal remedies where possible and conventional prophylaxis
Milk production	1 L/cow/day for 250 days	+10% in duration and production thanks to improved rearing conditions

Source : Study

Evolution of the agropastoralist's dairy herd in the Status Quo scenario (Table 4)

Table 4. Evolution of the agropastoralist's dairy herd in the Status Quo scenario (heads)

	TLU	Sires	Mature cows	Clothes (1 year)	Heifers (2 years)	Heifers-(3 years old)	Calves (1 year)	Bulls (2 years)	Bulls (3 years)	Milking cows
Year 0	11,4	1	10							
Year 1	12,4	1	10	3			2			5
Year 2	14,4	1	10	2	3		3	2		5
Year 3	18,4	1	10	3	2	3	2	3	2	5
Year 4	21,8	1	13	3	3	2	4	2	3	7
Year 5	24,8	1	15	4	3	3	4	4	2	8

Source : Study

Evolution of the agropastoralist's dairy herd in the AE Upgraded scenario (Table 4). In this scenario, the size of the herd increases more rapidly due to the higher success rate of matings (justified by better living conditions for the cows (improved feed, care and housing).

Table 5. Evolution of the agropastoralist's dairy herd in the AE Upgraded scenario (heads)

	TLU	Sires	Mature cows	Clothes (1 year)	Heifers (2 years)	Heifers-(3 years old)	Calves (1 year)	Bulls (2 years)	Bulls (3 years)	Milking cows
Year 0	11,4	1	10							0
Year 1	12,6	1	10	3			3			6
Year 2	15	1	10	3	3		3	3		6
Year 3	19,8	1	10	3	3	3	3	3	3	5
Year 4	23,2	1	13	4	3	3	4	3	3	7
Year 5	27,4	1	15	5	4	3	5	4	3	8

Source : Study

The feeding plans for the agropastor's milk production unit are shown in Table 6 and Table 7. In the AE Upgraded scenario, stored fodder co-products are mainly high-quality legume tops, whereas in the Status Quo scenario they are mainly cereal straws (low in energy and protein). In both scenarios, biomass coverage exceeds requirements in the first 2 or 3 years, as the farm's cultivated plots produce more than the dairy herd needs. This is no longer the case in years 3 and 5, as the dairy herd has increased in number of head and TLU.

Table 6. Agropastoralist's feeding plan for his dairy production unit in the Status Quo scenario

	Year 1	Year 2	Year 3	Year 4	Year 5
Herd biomass requirements (kgDM/year)	28 288	32 850	41 975	49 731	56 575
Covered by rangelands (kgDM/year)	16 973	19 710	25 185	29 839	33 945
Coverage of requirements by stored co-products (straw, tops in kgDM/year)	17 250	17 250	17 250	17 250	17 250
Covered by co-products purchased (haulm in kgDM/year)	0	0	0	2 725	4 960
Coverage of requirements by purchased concentrates (kgDM/year)	0	0	0	0	422
Coverage rate (%)	121%	113%	101%	100%	100%

Source : Study

Table 7. Agropastoralist's feeding plan for his dairy production unit in the AE Upgraded scenario

	Year 1	Year 2	Year 3	Year 4	Year 5
Dairy herd biomass requirements (kgDM/year)	28 744	34 219	45 169	52 925	62 506
Covered by rangelands (kgDM/year)	17 246	20 531	27 101	31 755	37 504
Coverage of requirements by stored co-products (straw, tops in kgDM/year)	17 000	16 750	16 500	16 250	16 000
Covered by co-products purchased (haulm in kgDM/year)	0	0	1 584	4 849	8 604
Coverage of requirements by purchased concentrates (kgDM/year)	0	0	0	348	411
Coverage rate (%)	119%	109%	100%	101%	100%

Source : Study

The Table 8 shows milk and animal sales over the 5 years. It can be seen that milk sales in the AE Upgraded scenario are higher than those in the Status Quo scenario for two reasons: 1) firstly, because from year 4ème onwards the number of cows milked is higher; and 2) also because we have applied a milk yield increase rate of 10% in this scenario due to the better rearing conditions. It should also be noted that sales are of 3-year-old bull calves.

Table 8. Sales of milk and animals from the agropastoralist's dairy production units in the Status Quo and AE Upgraded scenarios

	Year 1	Year 2	Year 3	Year 4	Year 5
Status Quo scenario					
Milk sales (L/year)	**1 250**	**1 250**	**1 250**	**1 750**	**2 000**
Livestock sales (head/year)	**0**	**0**	**2 (*)**	**3 (*)**	**2 (*)**
AE Upgraded scenario					
Milk sales (L/year)	**1 980**	**1 980**	**1 980**	**2 640**	**3 300**
Livestock sales (L/year)	**0**	**0**	**3 (*)**	**3 (*)**	**3 (*)**

Legend: (*) 3-year-old zebu bull calf

Characterization of the dairy production unit of an average mini-farm according to the Status Quo and AE Upgraded scenarios

We have considered that an "average" dairy mini-farm is made up of 3 production units: the extensive livestock production unit (from which the zebu cows destined for the dairy production unit are taken), a crop production unit (15 ha) intended mainly for self-consumption and the sale of surplus grain (production unit from which the mini-farm manager takes forage co-products to feed the animals of the dairy production unit) and finally the dairy production unit itself, which is the subject of this cost-benefit analysis.

As in the case of agropastoral farming, the mini-farm's dairy production unit is set up with 10 adult zebu cows selected from the mini-farm's cow-calf herd.

In contrast to the agropastoralist, the mini-farm's dairy production unit uses artificial insemination (AI; for 25,000 FCFA/act) for reproduction. This strategy differs from the agropastoralist's, where reproduction remains natural (provided by a zebu sire). In mini-farms, the farmer's objective is to gradually specialize in milk production, which is generally achieved through the progressive integration of genes from exotic dairy breeds using AI to increase milk production. In this CBA we have considered that this is done entirely by AI (some mini-farms have had access to imported exotic broodstock, but these remain very isolated cases).

The typical trajectory of an animal born in this dairy production unit is as follows:

- Females: Adult female zebu inseminated by AI=> Heifer F1 (1 year old) => Heifer F1 (2 years old) => Heifer F1 (3 years old) / inseminated by AI => Adult female F1 milked (+ calf or calf F2)
- Males: Adult female zebu => F1 calf (1 year old) => F1 bull calf (2 years old) => F1 bull calf (3 years old) => Sale

The basic feed is provided by grazing of natural pastures, which covers 25% of the ingested biomass (at a rate of 6.25 kgDM/day/TLU). We considered that on the mini-farm, dairy farm animals were much less dependent on grazing than agropastoralists (for agropastoralists, we considered that grazing covered 60% of the biomass ingested by dairy farm animals everyday).

Veterinary care was estimated at 10,000 Fcfa/TLU per year, with a reduction of 25% in the AE Upgraded scenario due to better breeding conditions (more balanced diet, better habitat, better water quality).

Personnel: 1 shepherd and 2 farm workers paid 25,000 FCFA/month and 20,000 FCFA/month respectively in the 2 scenarios. In the mini-farm, the number of farm workers is more significant because the cultivated area is much larger than that of the agro-pastoralist, since the animals in the dairy production unit graze less. This has to be compensated for by crops, forage and feed purchases.

Taxes: minimal (10,000 FCFA/year) in both scenarios.

Fluids and energy: only fuel to run the motorised tricycle at a cost of 5,000 FCFA/year/TLU (this value has been increased compared with the agropastoralist, as the driving mode is more intensive and the vehicle used is larger).

The parameters used for the mini-farm's dairy production unit are presented in Appendix 1 and Appendix 3.

The agroecological milk production package offered to the mini-farm is the same as that offered to the agro-pastoralist (see Box 1).

The main characteristics and differences between the Status Quo and AE Upgraded scenarios for the mini-dairy farm are presented in Table 9.

Table 9. Characteristics of the Status Quo and AE Upgraded scenarios for the mini-farm dairy production unit

	Status Quo	AE Upgraded
Artificial insemination success rate	60%	80% (improved due to better breeding conditions)
Equipment	Single park Bored classic well	Improved park with shelters, feeders (improved habitat) Drilling for a better water supply in terms of quantity and quality Manure pit
Crop rotation	Cultivated area: 15 ha No forage crops Cereal 90% Leguminous plants 10% of the total	Cultivated area: 15 ha Introduction of forage crops (10% in year 1 to 50% in year 5) Instead of cereals
Power supply	Rangeland (covers 25% of livestock biomass requirements) Forages, mainly cereal straw Reasoned purchase of concentrates and quality forages	Rangeland (covers 25% of livestock biomass requirements) Reinforced with quality forage Reasoned purchase of concentrates and quality forages
Health	Conventional prophylaxis	Use of herbal remedies where possible + conventional prophylaxis
Milk production	1 L/female zebu/day for 250 days 5 L/female F1/d over 250 d	+10% in duration and production thanks to improved rearing conditions

Source : Study

Evolution of the mini-farm's dairy herd in the Status Quo scenario (Table 10). The dairy herd, expressed in tropical livestock units (TLU), increases much more rapidly than the dairy herd of the agro-pastoralist because, according to our hypotheses, AI accelerates the number of births, and the animals born of AI (F1) are heavier than zebus.

Table 10. Evolution of the mini-farm's dairy herd in the Status Quo scenario (heads)

	TLU	Adult zb cows	Mature F1 cows	F1 skis (1 year)	F1 heifers (2 years old)	Heifers-F1 (3 years old)	F1 calves (1 year old)	Young bulls F1(2 years)	F1 bull calves (3 years)	Cows zb milked	F1 milking cows
Year 0	10										
Year 1	12,4	10		3			3			6	
Year 2	17,2	10		3	3		3	3		6	
Year 3	24,4	10		3	3	3	3	3	3	6	
Year 4	30	10	3	4	3	3	4	3	3	6	2
Year 5	37,2	10	6	5	4	3	5	4	3	7	3

Source : Study

Evolution of the mini-farm dairy herd in the AE Upgraded scenario (Table 11). The size of the herd increases faster due to the higher AI success rate in the AE Upgraded scenario.

Table 11. Evolution of the mini-farm's dairy herd in the AE Upgraded scenario (heads)

	TLU	Adult zb cows	Mature F1 cows	F1 skis (1 year)	F1 heifers (2 years old)	Heifers-F1 (3 years old)	F1 calves (1 year old)	Young bulls F1(2 years)	F1 bull calves (3 years)	Cows zb milked	F1 milking cows
Year 0	10	10									
Year 1	13,2	10		4			4			8	
Year 2	19,6	10		4	4		4	4		8	
Year 3	29,2	10		4	4	4	4	4	4	8	
Year 4	37,2	10	4	6	4	4	6	4	4	9	3
Year 5	47,6	10	8	7	6	4	7	6	4	10	4

Source : Study

Feeding plans for dairy animals are shown in Table 12 and Table 13. In the AE Upgraded scenario, stored fodder co-products are mainly high-quality legume tops, whereas in the Status Quo scenario, they are mainly cereal straws (low in energy and protein). In both scenarios, biomass coverage exceeds requirements in the first 2 or 3 years, as the farm's cultivated plots produce more than the dairy herd needs. This is no longer the case in years 4 and 5, as the dairy herd has increased in number of head and TLU.

Table 12. Feeding plan for the dairy farm in the Status Quo scenario

	Year 1	Year 2	Year 3	Year 4	Year 5
Herd biomass requirements (kgDM/year)	28 288	39 238	55 663	68 438	84 863
Covered by rangelands (kgDM/year)	7 072	9 809	13 916	17 109	21 216
Coverage of requirements by stored co-products (straw, tops in kgDM/year)	51 750	51 750	51 750	51 750	51 750
Covered by co-products purchased (haulm in kgDM/year)	0	0	0	0	7 440
Coverage of requirements by purchased concentrates (kgDM/year)	0	0	0	0	4 464
Coverage rate (%)	208%	157%	118%	101%	100%

Source : Study

Table 13. Feeding plan for the dairy farm in the AE Upgraded scenario

	Year 1	Year 2	Year 3	Year 4	Year 5
Dairy herd biomass requirements (kgDM/year)	30 113	44 713	66 613	84 863	108 588
Covered by rangelands (kgDM/year)	7 528	11 178	16 653	21 216	27 147
Coverage of needs by stored co-products (straw, haulm in kgDM/year)	51 000	50 250	49 500	48 750	48 000
Covered by co-products purchased (haulm in kgDM/year)	0	0	467	9 300	23 800
Coverage of requirements by purchased concentrates (kgDM/year)	0	0	0	5 580	9 615
Coverage rate (%)	194%	137%	100%	100%	100%

Source : Study

The Table 14 shows milk and animal sales over the 5 years. It can be seen that milk sales in the AE Upgraded scenario are higher than those in the Status Quo scenario for three reasons: firstly, because the number of cows milked is higher from year 4ème onwards; secondly, because the more milk-productive F1 females come into production from year 4ème onwards; and thirdly, because we have applied a 10% increase in milk yield in this scenario due to the better rearing conditions. It should also be noted that sales are of 3-year-old F1 bulls.

Table 14. Sales of milk and animals from the mini-farm's dairy production unit in the Status Quo and AE Upgraded scenarios

	Year 1	Year 2	Year 3	Year 4	Year 5
Status Quo scenario					
Zebu milk sales (L/year)	**1 500**	**1 500**	**1 500**	**1 500**	**1 750**
F1 milk sales (L/year)	**0**	**0**	**0**	**2 500**	**3 750**
Livestock sales (FCFA/year)	**0**	**0**	**3 (*)**	**3 (*)**	**3 (*)**
AE Upgraded scenario					
Zebu milk sales (L/year)	**2 640**	**2 640**	**2 640**	**2 970**	**3 300**
F1 milk sales (L/year)	**0**	**0**	**0**	**4 950**	**6 600**
Livestock sales (FCFA/year)	**0**	**0**	**4 (*)**	**4 (*)**	**4 (*)**

Legend: (*) 3-year-old zebu bull calf

Characterization of an average mini-dairy according to Status Quo and AE Upgraded scenarios

In Bobo-Dioulasso, the mini-dairies that process local milk generally produce pasteurized milk, plain sweetened yoghurt, dêguê (with small millet), gapal, and sometimes various milk drinks, cream, Peul cheese (Wagashi) and butter, at the request of customers. This meets the preferences expressed by consumers, who consume little milk (around 20 kg/capita/year), mainly in the form of yoghurt and pasteurized milk (Fayama et al., 2024).

Today, some of these dairies are seeking to diversify their production, leading them to innovate by offering yogurts flavored with natural extracts made from local non-wood forest products (néré, kinkéliba, moringa, zaigainai (Balanites), monkey bread (theodo), mangoes, dates, coconut) and non-wood products (pineapple, horchata (souchet), banana, sweet potatoes), as well as milk-based cosmetics (milk soap, milk oil, milk ointments). From an agroecological point of view, in these innovations, these processors mobilize the following two agroecological principles (according to the terminology proposed by Wezel et al. 2020): economic diversification (of dairy products), food traditions (valorization of local products such as dêguê, gapal, wagashi...).

To conduct this cost-benefit analysis of introducing a package of agroecological practices at the level of a mini-dairy, we based ourselves on the case of the Sanko dairy, simplifying its economic model. The data presented were collected from the dairy manager and adapted for simplification.

We considered that the innovative agroecological practice consisted in adding the production of néré yoghurt and milk soap (AE Upgraded Scenario) to production based on the transformation of milk into pasteurized milk, sweetened yoghurt and dêguê (Status Quo Scenario). For these innovative products, the margin per liter of milk is higher than for traditional products (Table 15).

The parameters used for the mini-dairy unit are presented in Appendix 4.

The Table 15 shows the characteristics of the Status Quo and AE Upgraded scenarios for such a mini-dairy. For the sake of simplicity, we have not taken into account all the dairy products traditionally produced or imagined by these dairies, but have confined ourselves to three flagship products offered by the mini-dairies (pasteurized milk, sweetened yoghurt and dêguê for the Status Quo scenario) and for the AE Upgraded scenario (these 3 products + yoghurt with néré and milk soap). In the Status Quo scenario, the share of milk processed for these three products is fixed, and sweetened yoghurt is the flagship product. In the AE Upgraded scenario, on the other hand, the dairy is betting that, over time, néré yoghurt and milk soap could become the two flagship products, to the detriment of sweetened yoghurt and dêguê (products offered by the majority of dairies).

Table 15. Characteristics of the Status Quo and AE Upgraded mini-dairy scenarios

	Status Quo	AE Upgraded
Range of dairy products	Pasteurized milk Sweetened yogurt Dêguê	Pasteurized milk Sweetened yogurt Dêguê Néré yogurt Milk soap
Production dynamics over 5 years	Proportion fixed over the years : Pasteurized milk (20% of processed milk) Sweetened yogurt (50% of processed milk) Dêguê (30% of processed milk)	Pasteurized milk (about 20% of processed milk) Sweetened yoghurt (45 to 43%) Dêguê (30% to 27%) Néré yogurt (5 to 7%) Milk soap (1% to 2%)
Equipment (see **Table 18**)	Equipment needed to produce pasteurized milk, yoghurt and dêgué in 30 cl cans.	Status quo + scenario equipment Acquisition of specific equipment to produce milk soap (soap molds, buffer table)
Staff	From 3 to 7 employees from year 1 to year 5, depending on sales growth	From 3 to 8 employees from year 1 to year 5, depending on sales growth
Fluids and energy	Consumption rises in proportion to the quantity of milk processed	Consumption rises in proportion to the quantity of milk processed
Production costs and benefits on dairy products	Costs and benefits increase in proportion to the quantity of milk processed	Costs and benefits increase in proportion to the quantity of milk processed
Margin per liter of milk processed (FCFA/L)	Pasteurized milk: 275 FCFA/L Sweetened yoghurt: 322 FCFA/L Dêguê: 356 FCA/L	Pasteurized milk: 275 FCFA/L Sweetened yoghurt: 322 FCFA/L Dêguê: 356 FCFA /L Néré yoghurt: 411 FCFA/L Milk soap : 1 700 FCFA/L

Source : Study

The Table 16 and Table 17 show the evolution of the volume of milk processed by the mini-dairy in the Status Quo scenario and in the AE Upgraded scenario. This evolution corresponds roughly to the evolution described by the Sanko dairy when simplifying the economic model to 5 dairy products. We can see that in both scenarios, the evolution of the quantity of milk processed over the years is identical (from 21,000 to 45,000 L of milk processed per year), in order to be able to compare the two scenarios (a comparison that would be difficult if the two scenarios were not based on a common base). This cost-benefit analysis of the two scenarios aims to verify that the development of innovative agroecological products can ultimately improve the dairy's economic performance.

Table 16. Evolution of the volume of milk processed by the mini-dairy in the Status Quo scenario (L/year)

	Quantity of milk processed per year	Pasteurized milk	Plain sweetened yogurt	Dégué	Néré yoghurt	Milk soap
Year 1	21 000	4 200	10 500	6 300	0	0
Year 2	24 000	4 800	12 000	7 200	0	0
Year 3	30 000	6 000	15 000	9 000	0	0
Year 4	36 000	7 200	18 000	10 800	0	0
Year 5	45 000	9 000	22 500	13 500	0	0

Source : Study

Table 17. Volume of milk processed by the mini-dairy in the AE Upgraded scenario (L/year)

	Quantity of milk processed per year	Pasteurized milk	Plain sweetened yogurt	Dégué	Néré yoghurt	Milk soap
Year 1	21 000	4 200	9 300	6 300	1 050	150
Year 2	24 000	4 800	10 200	7 500	1 200	300
Year 3	30 000	6 000	13 050	9 000	1 500	450
Year 4	36 000	7 200	15 600	10 500	2 100	600
Year 5	45 000	9 000	20 100	12 000	3 000	900

Source : Study

The Table 18 shows the mini-dairy's equipment according to the Status Quo and AE Upgraded scenarios. To diversify its production, the dairy had to slightly increase its equipment to produce soap.

Table 18. Mini-dairy equipment in the Status Quo and AE Upgraded scenarios

Equipment	Dairy products concerned	Status Quo	AE Upgraded
Whip sticks	DG	8	8
Plastic sieves	DG	6	6
Mortar	DG	2	2
Table	DG	1	1
Plastic bowl	DG	2	4
Gourds	DG	2	2
Skimmers	LP	1	1
Plastic containers	LP	3	3
Sorbotiere	LP	1	1
Saucepans	LP, YS, DG, YN	9	9
Gluing machine	LP, YS, DG, YN	5	5
Freezers	LP, YS, DG, YN	3	4
Refrigerators	LP, YS, DG, YN	1	1
Coolers	LP, YS, DG, YN	4	9
Cutting table	SV		1
Soap molds	SV		4
Soap pad	SV		2
Buffer table	SV		1
Plastic bucket	SV		2
Large spatulas	SV		2
Pots	TS	2	2
Gas fireplaces	TS	2	2
Barrels	TS	2	2
Lactodensimeter	TS	1	1
Thermometer	TS	3	3
Tricycles	TS	1	1
Motorcycle	TS	2	2

Legend: TS: all dairy products; LP: pasteurized milk; YS: sweetened yogurt; DG: dégué; YN: yogurt with néré; SV: soap.

Source : Study

Results

Cost-benefit analysis of the agropastoralist's dairy production unit

The Figure 2 and Figure 3 respectively show the evolution of costs and benefits for the agropastoralist's dairy production unit.

It should be noted that these figures do not include the cost of immobilizing animals (10 zebu cows removed from the farrowing herd in year 0 to form the core of the dairy production units), nor the benefits of recovering assets and livestock (value of dairy farm equipment and livestock in year 5). However, these capital costs and benefits from the recovery of assets and livestock have been incorporated into the CBA (Table 19). As they represent significant amounts (particularly for livestock) we have chosen not to include them in these two figures, to be able to visualize the evolution of other direct costs and benefits (cf. Table 1and Table 2).

Table 19. Livestock capital costs and asset recovery benefits (equipment and livestock) for the agropastoralist's dairy farm under the two scenarios (Status Quo and AE Upgraded)

Scenario	Status Quo	AE Upgraded
Capital cost of livestock in the dairy production unit in year 0 (FCFA)	5 200 000	5 200 000
Equipment recovery benefit in year 5 (FCFA)	250 000	552 500
Livestock recovery benefit in year 5 (FCFA)	9 675 000	10 550 000

The Figure 2 shows that for both scenarios, the main costs are: 1) equipment in year 0; 2) staff salaries over the 5 years; 3) and progressively the costs of fodder and feed purchases, which increase sharply from year 3ème or 4ème due to the increase in the dairy herd.

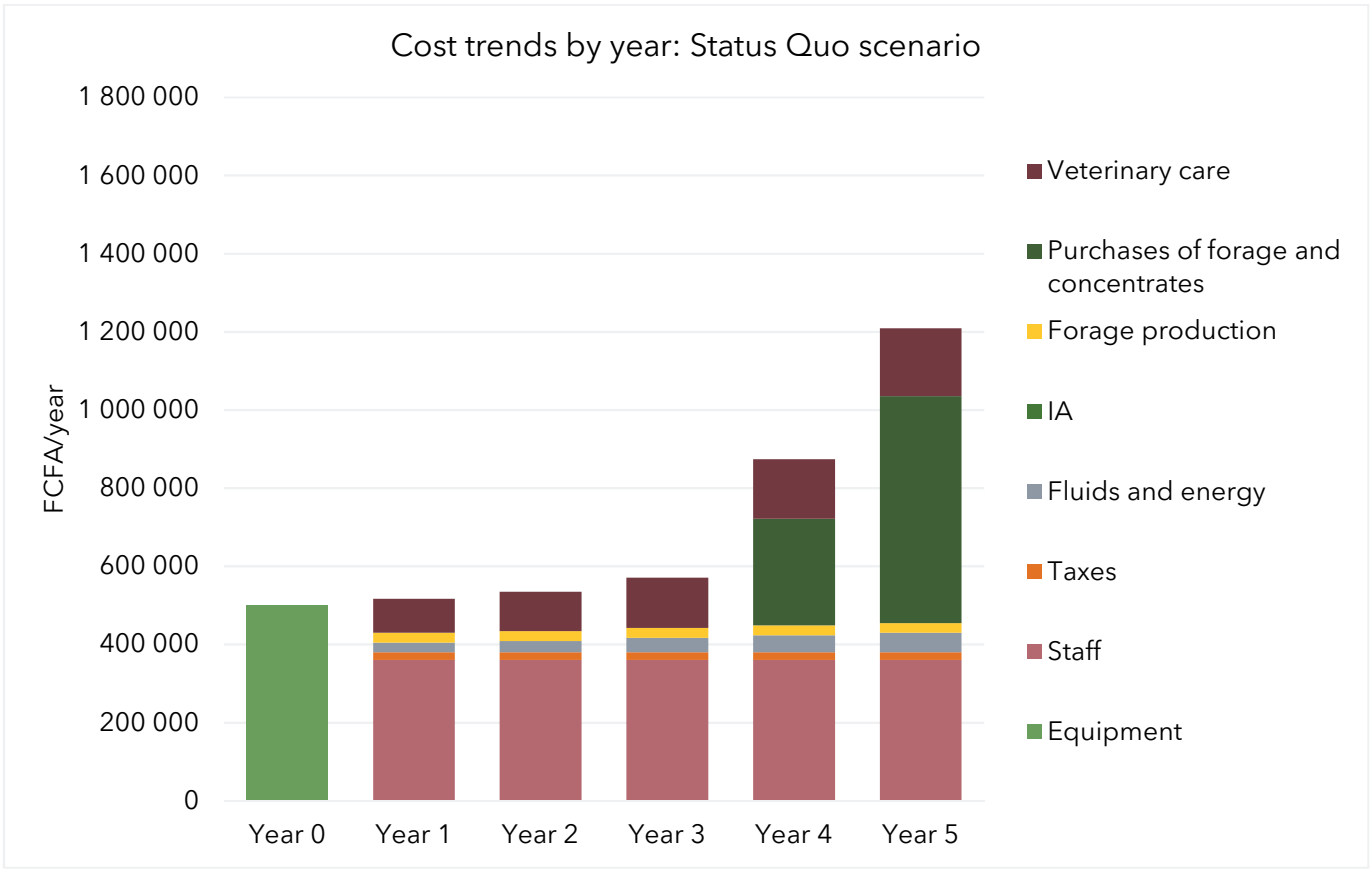
The Figure 3 shows that in both scenarios: 1) milk benefits increase significantly from the third year onwards, as females born in year 1 join the milking cow nucleus; 2) sales of bull calves represent a significant proportion of the farmer's income from his dairy production unit.

In the AE Upgraded scenario, the equipment investment cost is twice as high as in the Status Quo scenario. Expenditure on fodder and feed is much higher than in the Status Quo scenario. Expenditure on veterinary care is slightly lower, due to improved animal husbandry conditions and the partial use of medicinal plants.

The cost-benefit analysis of the agropastoralist's dairy production u nit according to the two scenarios (Status Quo and AE Upgraded) presented in Table 20 shows that :

1) In both scenarios, the agropastoralist makes a benefit from his dairy production unit (Net Present Value > 0; IRR (%) > Discount rate (6%); BCR > 1). This means that the dairy farm is viable with or without the agroecological scenario.
2) Integrating the package of agroecological practices into the dairy production unit (AE Upgraded scenario) significantly increases the economic performance of the agropastoralist's dairy production unit:
    a. Net Present Value of AE Upgraded scenario > Net Present Value of Status Quo scenario
    b. AE Upgraded IRR > Status Quo IRR
    c. AE Upgraded Scenario BCR > Status Quo Scenario BCR

In conclusion, it seems that integrating agroecological practices into an agropastoralist's dairy production unit improves economic performance and makes it more profitable.



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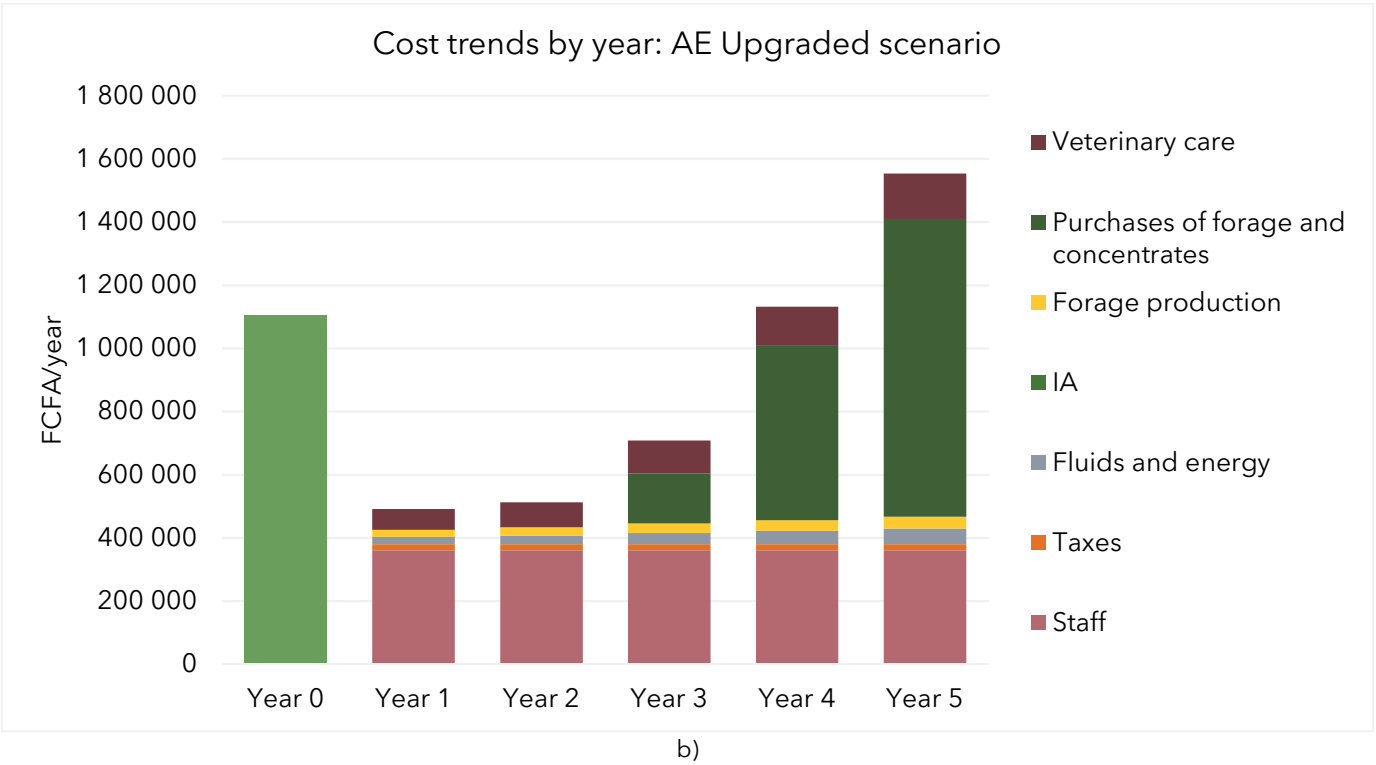

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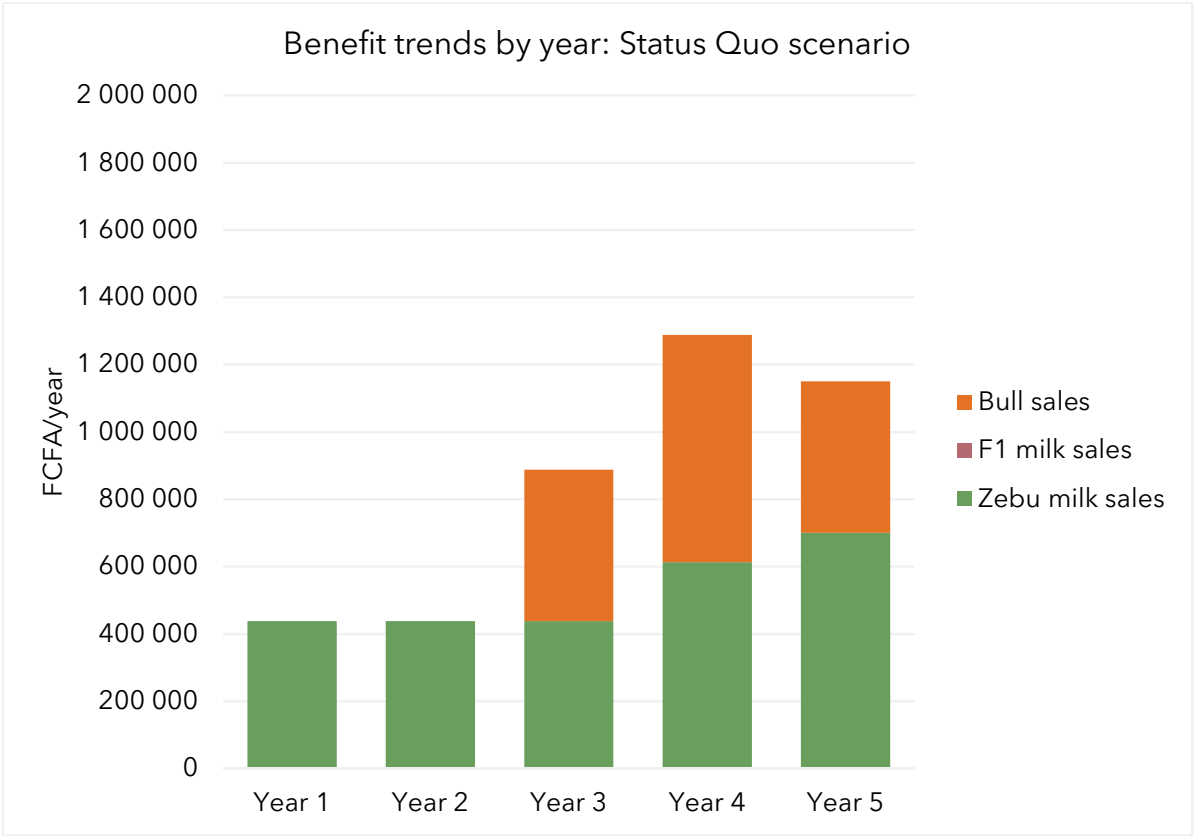
Figure 2. Evolution of production costs (excluding animal immobilization in year 0) in the agropastoralist's dairy production unit according to years and scenarios: a) Status quo; b) AE Upgraded



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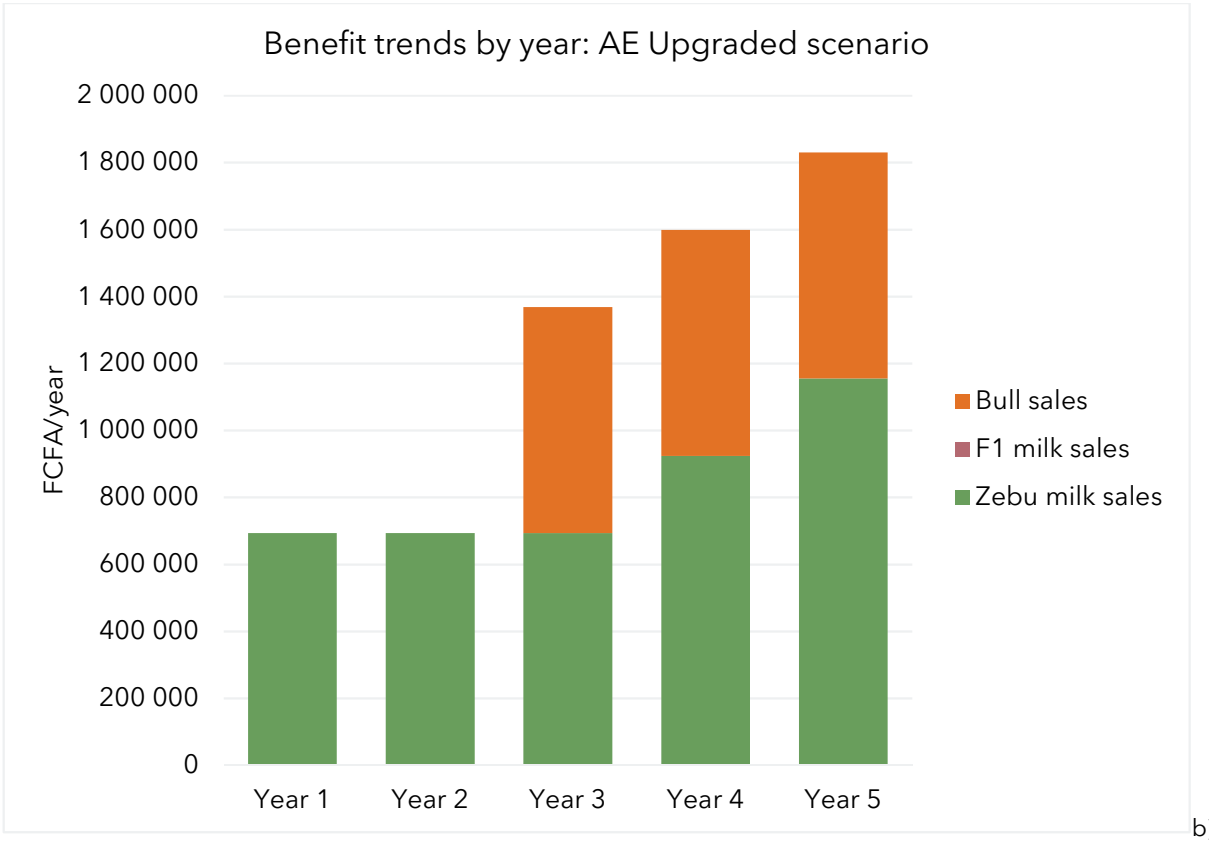

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Figure 3. Evolution of benefits (excluding recovery of assets and animals in year 5) in the agropastoralist's dairy production unit according to years and scenarios: a) Status quo; b) AE Upgraded

Table 20. Cost-benefit analysis of the agropastoralist's dairy production unit according to the two scenarios (Status Quo and AE Upgraded) – in USD

Scenario	Status Quo			AE Upgraded		
Year (t)	Benefits cashflow (Bt)	Costs cashflow (Bt)	Discounted Net Benefit	Benefits cashflow (Bt)	Costs cashflow (Bt)	Discounted Net Benefit
Year 0	0	9 628	-9 628	0	10 650	-10 650
Year 1	739	873	-126	1 171	830	321
Year 2	739	903	-146	1 171	865	272
Year 3	1 499	964	449	2 311	1 196	936
Year 4	2 175	1 476	554	2 701	1 912	625
Net Present Value (USD)			**3 557**			**5 868**
IRR (%)			**11,90%**			**16,40%**
Present Value of cashflows (USD)	**18 315**	**14 758**		**22 549**	**16 681**	
BCR			**1.24**			**1.35**

Cost-benefit analysis of the mini-farm's dairy production unit

The Figure 4 and Figure 5 respectively show the evolution of costs and benefits for the mini-farm's dairy production unit.

It should be noted that these figures do not include the cost of immobilizing animals (10 zebu cows removed from the farrowing herd in year 0 to form the core of the dairy farm), nor the benefits of recovering assets and livestock (value of dairy farm equipment and livestock in year 5). However, these capital costs and asset recovery benefits have been incorporated into the CBA (Table 21), but as they represent significant amounts (particularly for livestock) we have chosen not to include them in these two figures, to be able to visualize the evolution of other direct costs and benefits (cf. Table 1 and Table 2).

Table 21. Livestock capital costs and asset recovery benefits (equipment and livestock) for the mini-farm's dairy unit under the two scenarios (Status Quo and AE Upgraded)

Scenario	Status Quo	AE Upgraded
Capital cost of dairy herd in year 0 (FCFA)	4 500 000	4 500 000
Equipment recovery benefit in year 5 (FCFA)	812 500	1 737 500
Livestock recovery benefit in year 5 (FCFA)	16 450 000	20 050 000

The Figure 4 shows that, for both scenarios, the main costs are: 1) equipment in year 0; 2) staff salaries over the 5 years; 3) gradually, the costs of purchasing forage and feed, which increase sharply from year 3ème or 4ème onwards as the dairy herd grows to include larger animals (F1 animals) with higher biomass intake requirements; 4) and finally, to a lesser extent, expenditure on AI and health care.

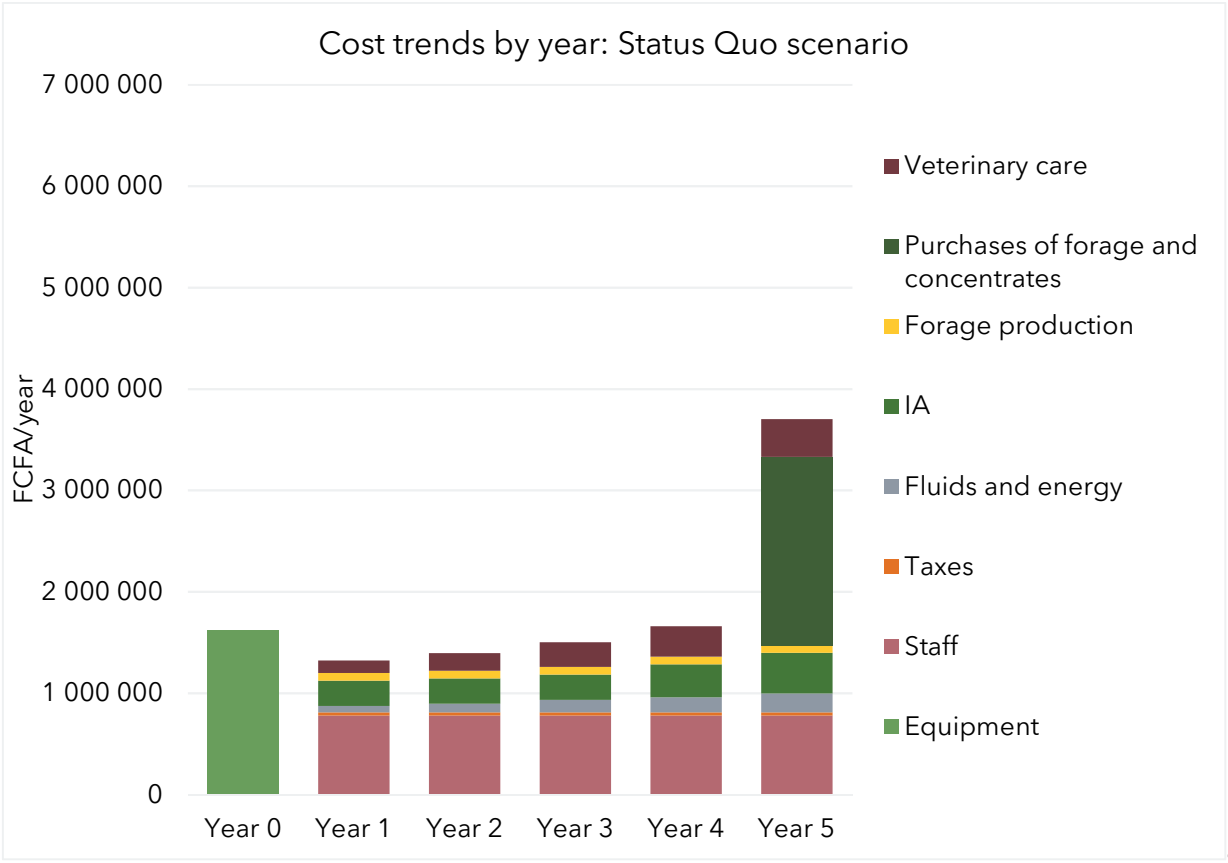
The Figure 5 shows that in both scenarios: 1) milk benefits increase significantly from the third year onwards when females born in year 1 join the milking cow nucleus (and above all due to the much higher milk yields of F1 females compared with zebu females: yields around 5 times higher); 2) sales of bull calves must be counted on, as they represent a significant proportion of the income that the mini-farm derives from its dairy production unit.

In the AE Upgraded scenario, the equipment investment cost is twice as high as in the Status Quo scenario. Fodder and feed purchase expenditures are much higher than in the Status Quo scenario from year 3 onwards. Expenditure on veterinary care is slightly lower, due to improved animal husbandry conditions and the partial use of medicinal plants.

The cost-benefit analysis of the mini-farm's dairy production unit according to the two scenarios (Status Quo and AE Upgraded) presented in Table 22 shows that :

3) In both scenarios, the mini-farm makes a benefit from its dairy production unit (Net Present Value > 0; IRR (%) > Discount rate (6%); BCR > 1). This means that the dairy production unit is viable with or without the agroecological scenario.
4) The integration of the agroecological practices package (Scenario AE Upgraded) significantly improves the economic performance of the mini-farm's dairy production unit:
    a. AE Upgraded Scenario Net Present Value > Status Quo Scenario Net Present Value
    b. AE Upgraded IRR > Status Quo IRR
    c. AE Upgraded Scenario BCR > Status Quo Scenario BCR

In conclusion, it seems that integrating agroecological practices into a mini-farm's dairy production unit improves its economic performance and makes it more profitable.



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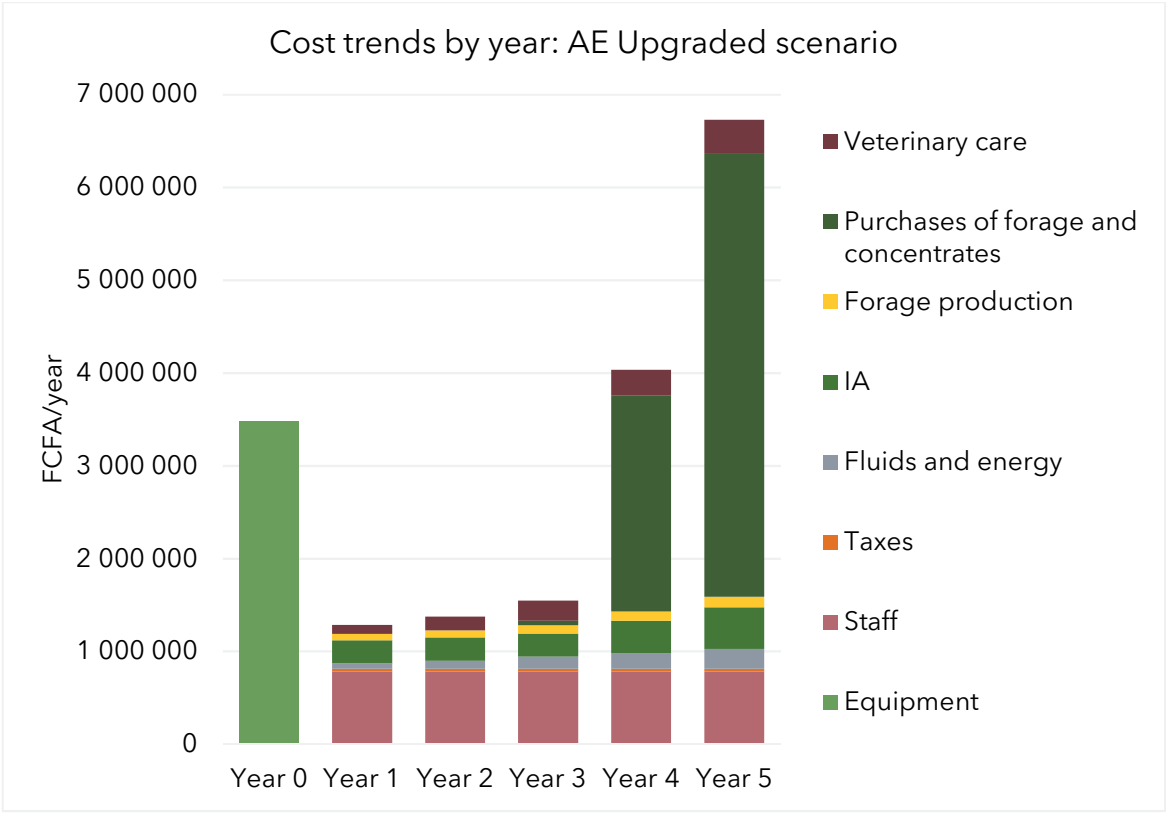

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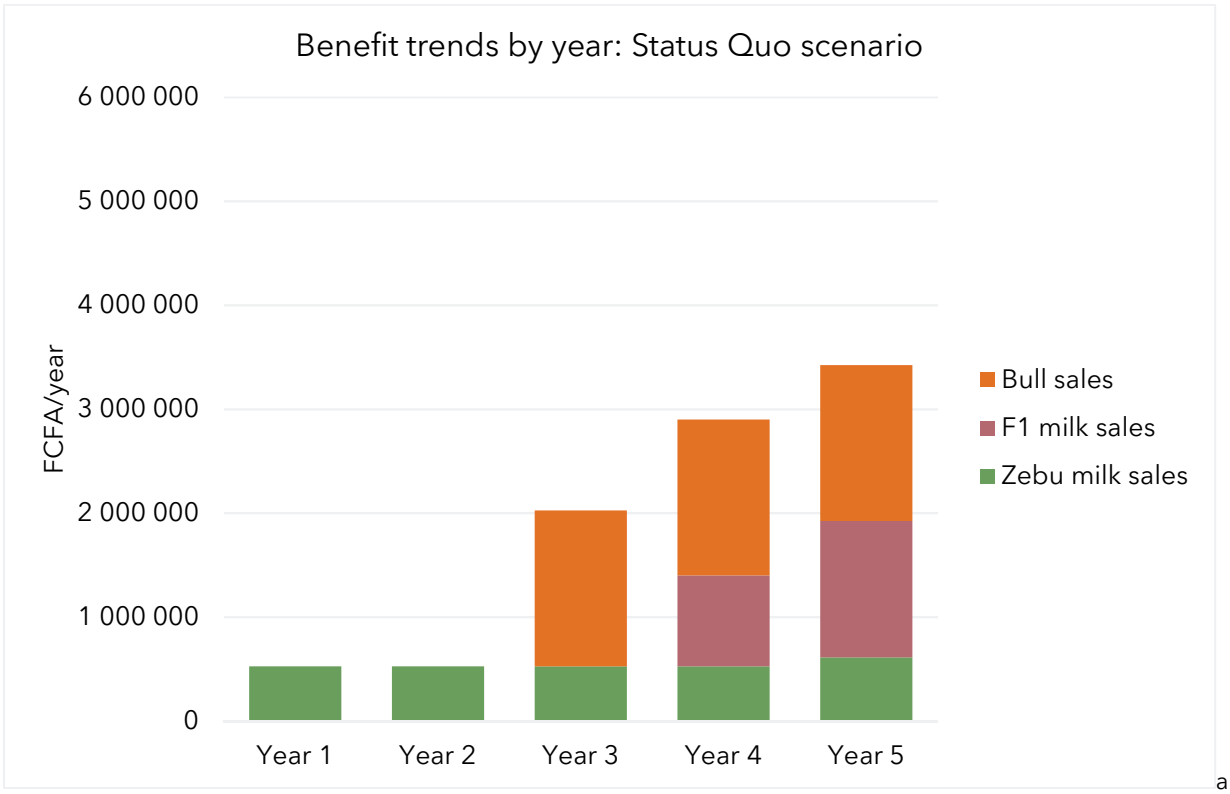
Figure 4. Evolution of production costs (excluding animal immobilization in year 0) in the mini-farm dairy production unit according to years and scenarios: a) Status quo; b) AE Upgraded



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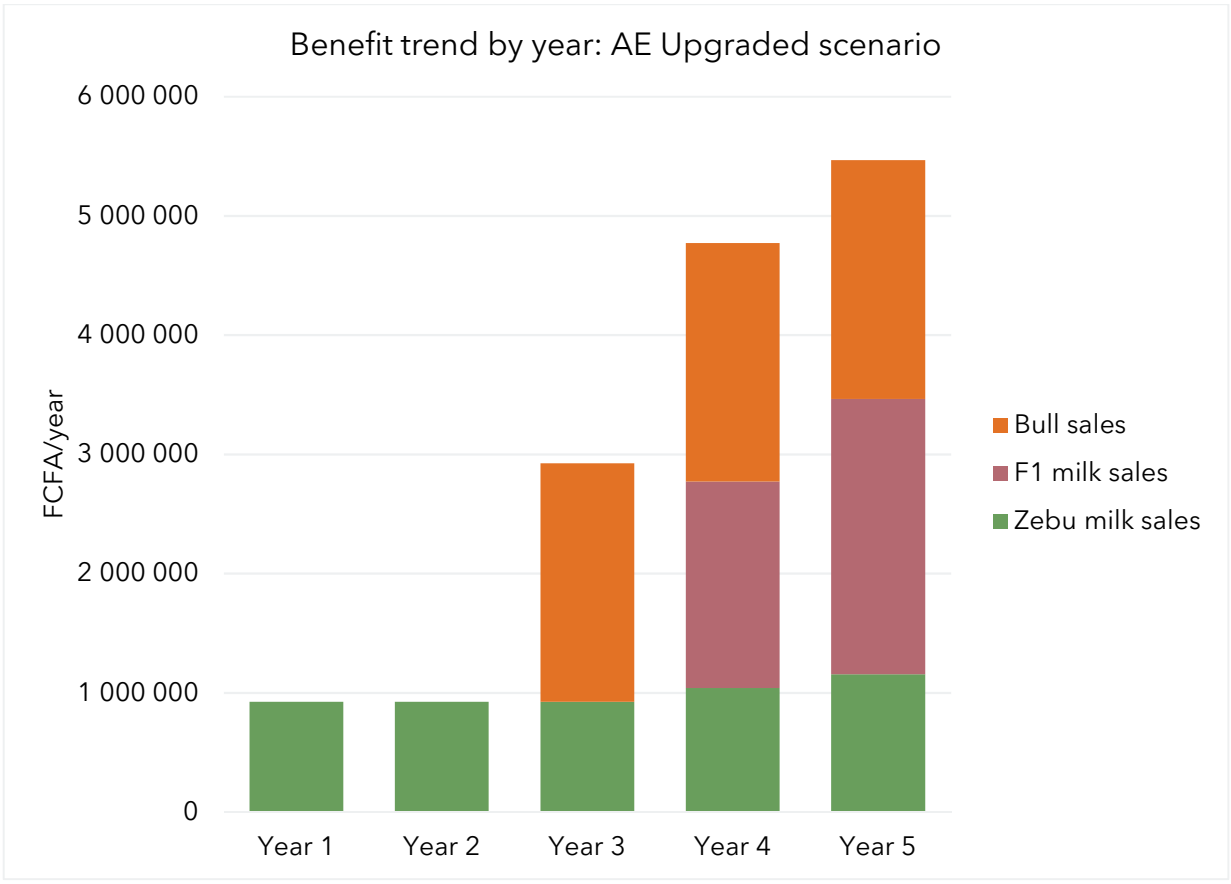

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Figure 5. Evolution of benefits (excluding recovery of assets and animals in year 5) in the mini-farm's dairy production unit by year and by scenario: a) Status quo; b) AE Upgraded

Table 22. Cost-benefit analysis of the mini-farm's dairy production unit according to the two scenarios (Status Quo and AE Upgraded) – in USD

Scenario	Status Quo			AE Upgraded		
Year (t)	Benefits cashflow (Bt)	Costs cashflow (Bt)	Discounted Net Benefit	Benefits cashflow (Bt)	Costs cashflow (Bt)	Discounted Net Benefit
Year 0	0	10 346	-10 346	0	13 470	-13 470
Year 1	887	2 231	-1 268	1 561	2 172	-577
Year 2	887	2 353	-1 305	1 561	2 321	-676
Year 3	3 420	2 535	743	4 939	2 613	1 953
Year 4	4 898	2 804	1 659	9 231	6 811	1 916
Net Present Value (USD)			**10 921**			**14 730**
IRR (%)			**19,10%**			**23,00%**
Present Value of cashflows (USD)	**34 489**	**23 568**		**48 395**	**33 666**	
BCR			**1.46**			**1.44**

Cost-benefit analysis of the mini-dairy

The Table 23 shows the share of ingredients in the production costs of the five dairy products (in %), as well as their production costs, benefits and margins (in FCFA/L of processed milk). It can be seen that, except for milk soap, milk accounts for by far the largest share of production costs (between 40% and 60%). For liquid products, packaging accounts for the second-largest share of production costs (between 28 and 45%). For milk soap, various ingredients (shea butter, cream, coconut oil, etc.) account for the bulk of production costs.

If we look at margins (in FCFA/L of milk processed), we see that milk soap, néré yoghurt and dêguê occupy the top three places. So, if the dairy finds a demand and a market for its two innovative products (yoghurt made with néré and milk soap), then developing their production should be profitable.

Table 23. Shares of ingredients in production costs (in %), and production costs, benefits and margins (in FCFA/L of milk processed) according to the mini-dairy's dairy products

Share of ingredients in production costs (%)	Pasteurized milk	Sweetened yogurt	Dêgué	Néré yogurt	Milk soap
Milk	62%	43%	40%	42%	6%
Various ingredients	7%	12%	14%	11%	89%
Gas	3%	2%	2%	2%	3%
Packaging	28%	43%	43%	45%	2%
Production costs, Benefits, Margins					
Cost FCFA/L of processed milk	725	1 053	1 112	1 074	7 321
Benefit FCFA/L of processed milk	1 000	1 375	1 469	1 430	8 750
Margin FCFA/L of processed milk	275	322	356	356	1 429

The Figure 6 and Figure 7 respectively show the evolution of costs and benefits for the mini-dairy.

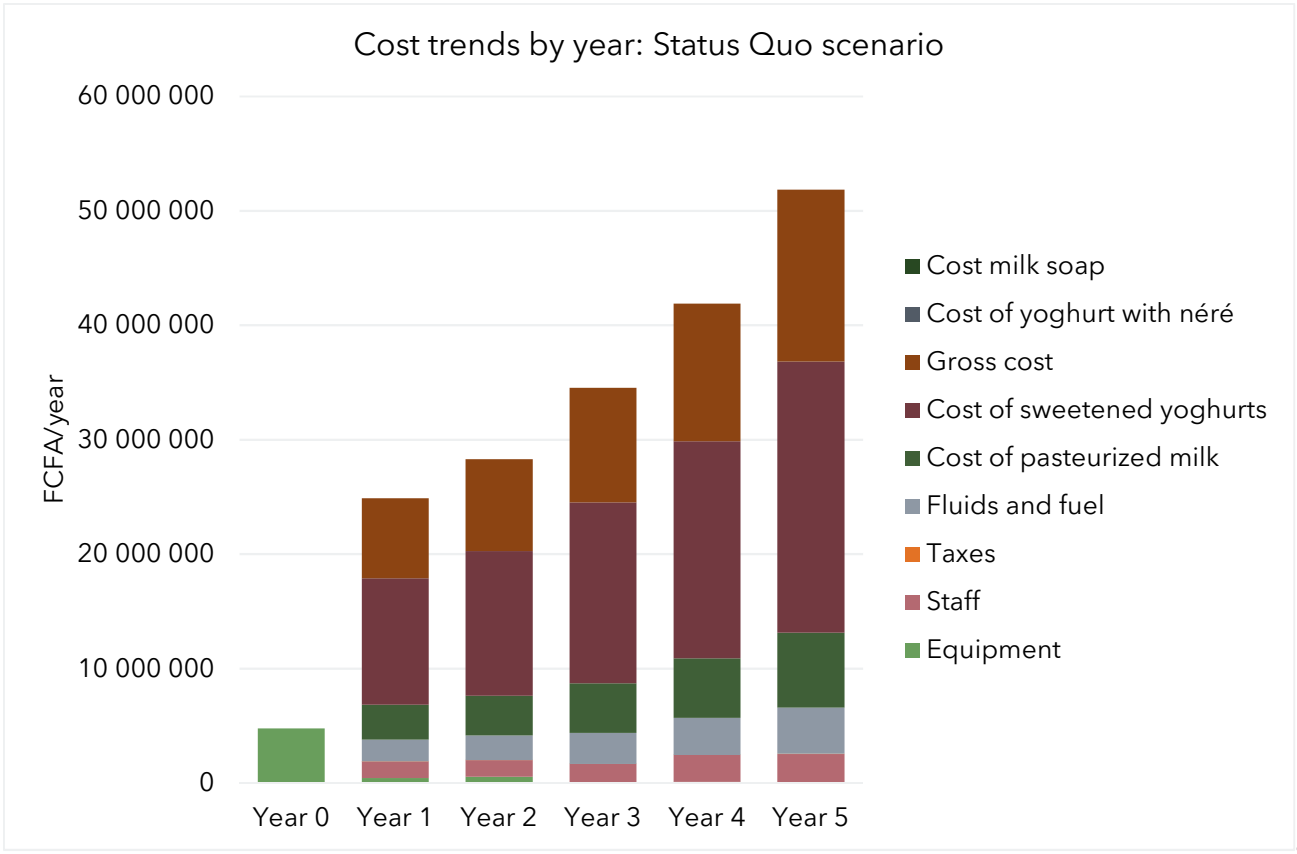
Figure 6 a) shows that in the Status Quo scenario, production costs for sweetened yoghurt, dêguê, and pasteurized milk occupy the top three places in annual production costs. Equipment, personnel, fluids and energy are a distant second. Figure 6 b) (AE Upgrade scenario) shows that the production costs of néré yoghurt and milk soap rise rapidly as the dairy increases the share of these products in its production.

The Figure 7a shows that in the Status Quo scenario, the mini-dairy earns most of its benefits from the sale of sweetened yoghurts, followed by dêguê and finally pasteurized milk. In the AE Upgraded scenario (Figure 7b) we see that the share of benefits derived from sweetened yoghurts decreases in favor of sales of dêguê yoghurts and milk soap.

The cost-benefit analysis of the mini-dairy according to the two scenarios (Status Quo and AE Upgraded) presented in Table 24 shows that :

5) In both scenarios, the mini-dairy makes a benefit (Net Present Value > 0; IRR (%) > Discount rate (6%); BCR > 1). This means that the mini-dairy is viable with or without the agroecological scenario.
6) The integration of the agroecological product package, such as néré yogurt and milk soap (AE Upgraded scenario), significantly improves the economic performance of the mini-dairy:
    d. Net Present Value of AE Upgraded scenario > Net Present Value of Status Quo scenario
    e. AE Upgraded IRR > Status Quo IRR
    f. AE Upgraded Scenario BCR > Status Quo Scenario BCR

In conclusion, it seems that diversification of dairy products, and more specifically the marketing of products with a higher margin than traditional products, but also a more marked agroecological character (cowpea yoghurt and milk soap), improves the economic performance of the mini-dairy and makes this dairy production unit more profitable.



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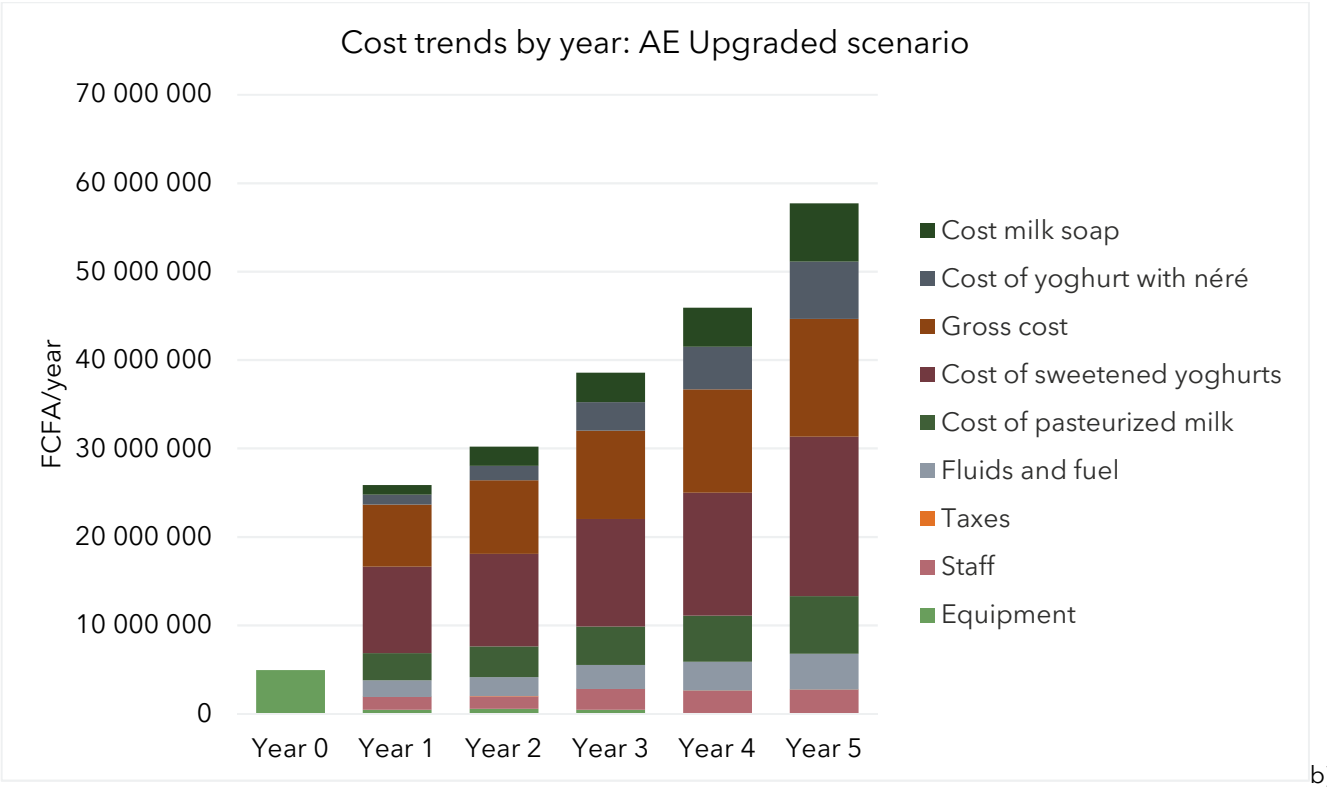

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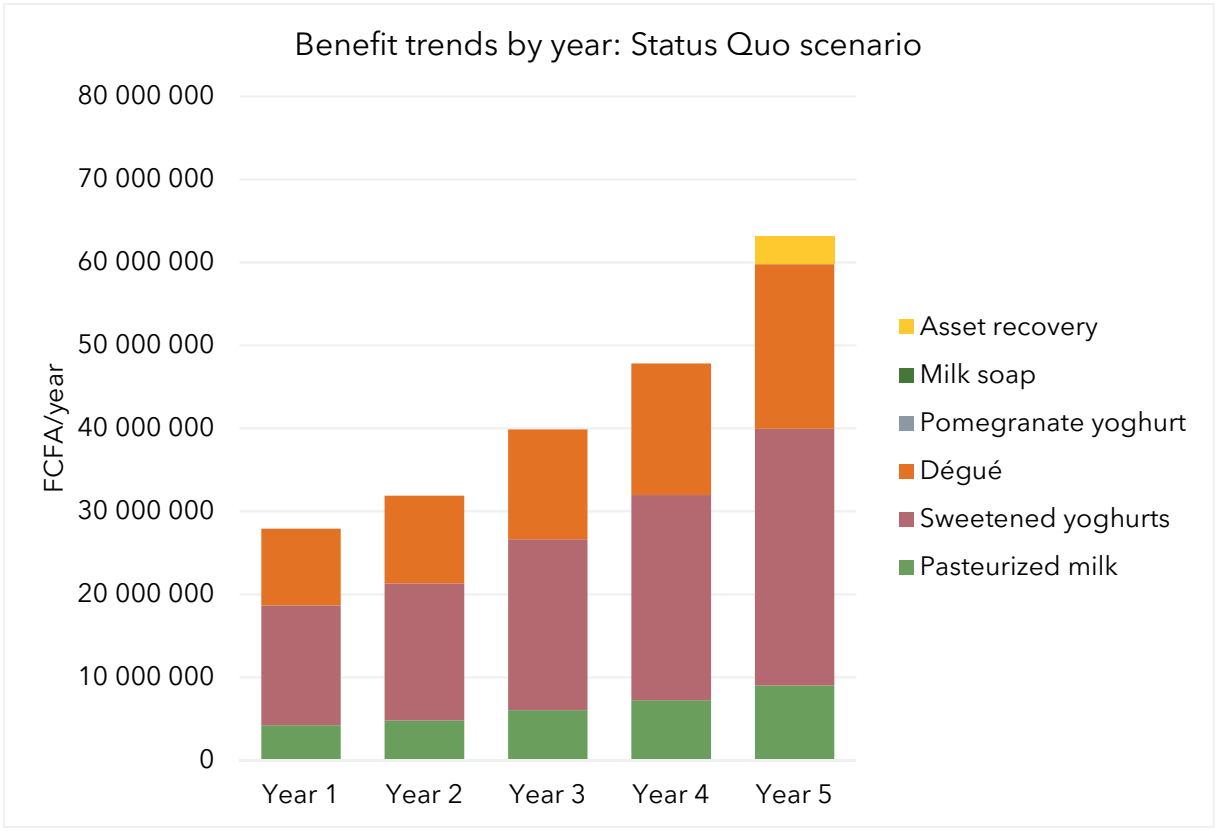
Figure 6. Evolution of mini-dairy production costs by year and by scenario: a) Status quo; b) AE Upgraded



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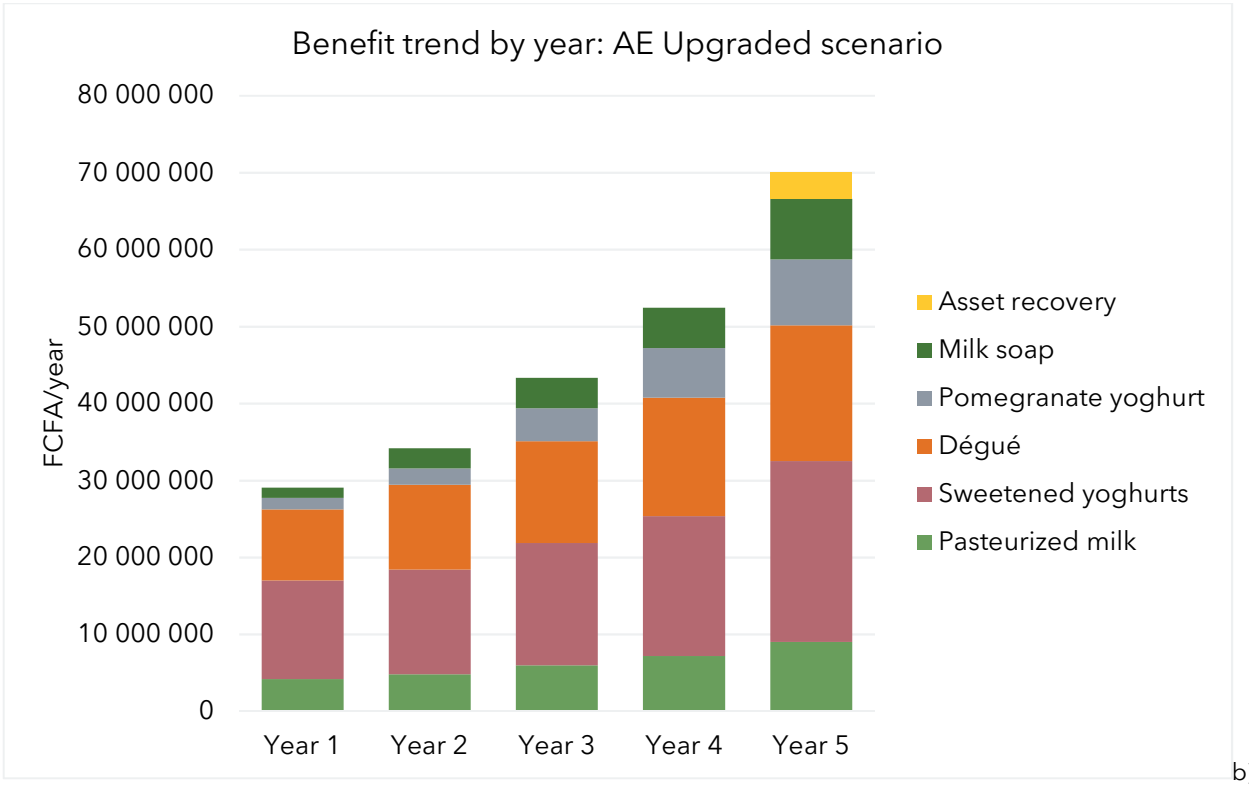

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Figure 7. Evolution of mini-dairy benefits by year and by scenario: a) Status quo; b) AE Upgraded

Table 24. Cost-benefit analysis of the mini-dairy according to the two scenarios (Status Quo and AE Upgraded) – in USD

Scenario	Status Quo			AE Upgraded		
Year (t)	Benefits cashflow (Bt)	Costs cashflow (Bt)	Discounted Net Benefit	Benefits cashflow (Bt)	Costs cashflow (Bt)	Discounted Net Benefit
Year 0	0	8 066	-8 066	0	8 356	-8 356
Year 1	47 109	42 039	4 783	49 075	43 689	5 082
Year 2	53 839	47 760	5 410	57 763	51 020	6 001
Year 3	67 299	58 303	7 553	73 183	65 097	6 789
Year 4	80 759	70 724	7 948	88 604	77 514	8 784
Net Present Value (USD)			31 851			33 832
IRR (%)			72%			82%
Present Value of cashflows (USD)	292 475	260 624		317 683	283 851	
BCR			1.12			1.12

Discussion and conclusion

The three CBAs show that deployment of the AE Upgraded Scenario improves the economic performance of the mini-dairy and the dairy production units of an agro-pastoralist and a mini-farm (Table 25).

Table 25. Summaries of cost-benefit analyses for the agropastoralist's dairy production unit, the mini-farm's dairy production unit and the mini-dairy according to the two scenarios (Status Quo and AE Upgraded) – in USD

Actors of the dairy value chain	Agropasto. dairy production unit		Mini-farm dairy production unit		Mini-dairy	
Scenarios	**Status Quo**	**AE Upgraded**	**Status Quo**	**AE Upgraded**	**Status Quo**	**AE Upgraded**
Net Present Value (USD)	3 557	5 868	10 921	14 730	31 851	33 832
IRR (%)	11 %	16 %	19 %	23 %	72 %	82 %
Present Value of cashflows (USD): benefits	18 315	22 549	34 489	48 395	292 475	317 683
Present Value of cashflows (USD): costs	14 758	16 681	23 568	33 666	260 624	283 851
BCR	1.24	1.35	1.46	1.44	1.12	1.12

In the case of the agro-pastoralist and mini-farm dairy production units, this improvement is due to better rearing conditions for dairy unit animals, through improved feed and housing conditions, which generate three types of effect: 1) improved reproductive performance (by natural breeding in the case of the agro-pastoralist; or by AI in the case of the mini-farm), leading to faster herd growth in the AE Upgraded scenario; 2) higher milk yields (around 10%) thanks to better feed and living conditions for the animals; 3) by a reduction in health costs due to improved animal condition and a rational use of medicinal plants; 4) and finally by the limitation or reduction of certain production costs (fodder thanks to the replacement of mineral fertilizers by organic manure, and the limitation of the use of animal feed).

For the two types of farmes (agro-pastoral and mini-dairy), the two dairy production units ar based on the selection of 10 adult zebu females from the extensive livestock herd. However, with the assumptions made about the performance of artificial insemination (mini-farm) and natural mating (agro-pastoralist), as well as the milk yields of zebu females and F1 dairy cows (1 L/d/head vs. 5 L/d/head), it can be seen that the mini-farm quickly shows much better economic performance than the agro-pastoralist dairy unit. However, the mini-farm model requires a higher initial investment and good access to AI. This undoubtedly explains why the agropastoral model is still the dominant one today.

In the mini-dairy case, the economic performance improvement in the AE Upgraded scenario is explained by the increased production of innovative dairy products (néré yoghurt and milk soap). These products offer higher margins than traditional products. In the AE Upgraded scenario presented, the share of these new products has been deliberately limited, as at this stage the dairy is not 100% certain of finding a demand and a market for these new products. However, we can see that even if the share of these products in sales remains marginal, they very quickly positively affect the mini-dairy's benefits and profitability.

In conclusion, these CBAs show that stakeholders of the Bobo-Dioulasso dairy value chain can probably make more money by implementing som agroecological principles in dairy farms and dairy processing units.

References

Fayama T, Sodré E, Sib O, and Dabiré D, 2024. Study report on consumer preferences for milk and dairy products in Bobo-Dioulasso. Working document, 30 p.

Narjes M, Gonzalez C, and Charry A, 2024. Cost-Benefit Analysis of agroecologically upgraded business models: A practitioner's guide. AEI, WP3, Working Document. 12 p

Sib O, Vall E, Corniaux C, Sodré E, and Sanogo S, 2023 (d). Characterising the dairy value chain from an agroecological perspective in the peri-urban area of Bobo-Dioulasso, Burkina Faso's 'Agroecological Living Landscape' focus area. Working document, 39 p.

Wezel A, Gemmill Herren B, Bezner Kerr R, Barrios E, Rodrigues Gonçalves A L, Sinclair F (2020) Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. Agron Sustain Dev 40: 40. doi.org/10.1007/s13593-020-00646-z

Appendices

Appendix 1. Characteristics of animals (live weight in kg and corresponding tropical livestock units, price per head) used in the agropastoral and mini-farm production units CBA

Type of animal	PV (kg)	TLU	Value (FCFA/head)
Zebu Sire	350	1,40	700 000
Adult female zb	250	1,00	450 000
1-year-old female calve zb	50	0,20	50 000
2-years-old heifer zb	100	0,40	100 000
3-years-old heifer zb	200	0,80	225 000
1-year old male calve zb	50	0,20	50 000
2-years-old-bull zb	100	0,40	100 000
3-years-odl-bull zb	200	0,80	225 000
Exotic Sire	600	2,40	3 000 000
Adult female F1	400	1,60	850 000
1-year-old female calve F1	100	0,40	125 000
2-years-old heifer F1	200	0,80	325 000
3-years-old heifer F1	300	1,20	500 000
1-year-old male calve F1	100	0,40	125 000
2-years-old bull F1	200	0,80	325 000
3-years-old bull F1	300	1,20	500 000

Appendix 2. Parameters used in the CBA of the dairy production unit of the average agropastoralist according to the scenario

Parameters	Status Quo	AE Upgraded
Traditional yard for cattle	FCFA 50,000	x
Improved yard for cattle	x	FCFA 250,000
Traditional bored weel	1,000,000 FCFA	X
Improved bored well	x	FCFA 2,000,000
Plastic milk cans	10,000 FCFA	X
Aluminium milk cans	x	FCFA 35,000
Motorcycle	600,000 FCFA	600,000 FCFA
Shepherd salary	15,000 FCFA/month	15,000 FCFA/month
Farm worker salary	15,000 FCFA/month	15,000 FCFA/month
Taxes	10,000 FCFA/year	10,000 FCFA/year
Fluids and energy	2,000 FCFA/TLU/year	1,800 FCFA/TLU/year
Natural mating success rate	50%	60%
Forage yield cereals (maize, sorghum, millet)	3,500 kgDM/ha	3,500 kgDM/ha
Forage yield of legumes (cowpeas, groundnuts)	3,000 kgDM/ha	3,000 kgDM/ha
Forage yield	x	3,500 kgDM/ha
Production cost of cereal straw	5,000 FCFA/ha	3,750 FCFA/ha
Production cost of leguminous tops	5,000 FCFA/ha	3,750 FCFA/ha
Production cost of forage crops	15,000 FCFA/ha	11,250 FCFA/ha
Ingestion of a TLU	6.25 kgDM/d/TLU	6.25 kgDM/d/TLU
Rate of coverage of DM needs by routes	60%	60%
Average forage price	100 FCFA/kg	100 FCFA/kg
Average price of livestock feed	200 FCFA/kg	200 FCFA/kg
Veterinary care per TLU per year	7,000 FCFA/TLU	5,250 FCFA/TLU
Female zebu milk yield	1 L/L	1.1 L/J
Farm-gate milk price per liter	350 FCFA/L	350 FCFA/L
Lactation duration	250 days	300 days

Appendix 3. Parameters used in the CBA of the average mini-farm's dairy production unit according to scenario

Parameters	Status Quo	AE Upgraded
Traditional yard for cattle	FCFA 50,000	x
Improved yard for cattle	x	FCFA 500,000
Bored well	FCFA 2,000,000	x
Drilling with solar panels		FCFA 6,000,000
Aluminium milk jars	FCFA 35,000	
Stainless steel milk jars	x	45,000 FCFA
Motorized tricycle	FCFA 1,200,000	FCFA 1,200,000
Shepherd salary	FCFA 25,000/month	FCFA 25,000/month
Farm worker salary	20,000 FCFA/month	20,000 FCFA/month
Taxes	10,000 FCFA/year/employee	10,000 FCFA/year/employee
Fluids and energy	5,000 FCFA/TLU/year	4,500 FCFA/TLU/year
Artificial insemination (AI) success rate	60%	80%
AI costs	25,000 FCFA/act	25,000 FCFA/act
Forage yield cereals (maize, sorghum, millet)	3,500 kgDM/ha	3,500 kgDM/ha
Forage yield of legumes (cowpeas, groundnuts)	3,000 kgDM/ha	3,000 kgDM/ha
Forage yield	x	3,500 kgDM/ha
Production cost of cereal straw	5,000 FCFA/ha	3,750 FCFA/ha
Production cost of leguminous tops	5,000 FCFA/ha	3,750 FCFA/ha
Production cost of forage crops	15,000 FCFA/ha	11,250 FCFA/ha
Ingestion of a TLU	6.25 kgDM/d/TLU	6.25 kgDM/d/TLU
Rate of coverage of DM needs by routes	25%	25%
Average forage price	100 FCFA/kg	100 FCFA/kg
Average price of livestock feed	200 FCFA/kg	200 FCFA/kg
Veterinary care per TLU	10,000 FCFA/TLU	7,500 FCFA/TLU
Female zebu milk yield	1 L/L	1.1 L/J
F1 female milk yield	5 L/L	5.5 L/J
Farm-gate milk price per liter	350 FCFA/L	350 FCFA/L
Lactation duration	250 days	300 days

Appendix 4. Parameters used in the CBA of the mini-dairy according to scenario

Parameters	Unit	Status Quo	AE Upgraded
Equipment			
Marmite	FCFA/u	30 000	idem
Saucepans	FCFA/u	15 000	Idem
Gas fireplace	FCFA/u	65 000	Idem
Skimmer	FCFA/u	225 000	idem
Plastic container	FCFA/u	35 000	idem
Barrels	FCFA/u	22 000	Idem
Sorbotiere	FCFA/u	475 000	Idem
Lactodensimeter	FCFA/u	30 000	idem
Thermometer	FCFA/u	15 000	idem
Gluing machine	FCFA/u	20 000	Idem
Whisk sticks (yogurt, dégué)	FCFA/u	8 000	Idem
Plastic sieves (yogurt, degummed)	FCFA/u	2 000	idem
Mortar (disguised)	FCFA/u	16 500	idem
Table (disguised)	FCFA/u	60 000	Idem
Plastic bowl (degreaser, soap)	FCFA/u	1 000	Idem
Calabashes (disguised)	FCFA/u	1 000	idem
Cutting table (soap)	FCFA/u	X	75 000
Moulds (soap)	FCFA/u	X	3 750
Soap pad	FCFA/u	X	12 500
Buffer table (soap)	FCFA/u	X	7 500
Plastic lime (soap)	FCFA/u	X	7 000
Large spatulas (soap)	FCFA/u	X	2 500
Freezer	FCFA/u	387 500	idem
Refrigerator	FCFA/u	495 000	Idem
Coolers	FCFA/u	14 000	idem
Tricycle	FCFA/u	1 150 000	Idem
Motorcycle	FCFA/u	750 000	Idem
Workforce			
Permanent work (pasteurization-packaging)	FCFA/month	30 000	idem
Permanent work (distribution)	FCFA/month	30 000	Idem
Permanent work (maintenance)	FCFA/month	15 000	Idem
Manager	FCFA/month	75 000	idem
Fluids and energy (FCFA/L processed milk)			
Electricity	FCFA/L milk	20	idem
Water	FCFA/L milk	20	Idem
Fuel	FCFA/L milk	50	Idem
Taxes			
Town hall tax	FCFA/year	6 000	idem
Hygiene service charge	FCFA/employee /Quarter	1 000	idem

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