Circular Solutions for the Poultry Sector in Côte d'Ivoire: Analysing three business cases

Final report

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This report is commissioned by the Netherlands Food partnership in close collaboration with the Embassy of the Kingdom of the Netherlands in Cote D'Ivoire with a vision of improving the poultry value chain through long term consultation, cooperation and collaboration with stakeholders in the chain.

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Résumé exécutif

La Côte d'Ivoire dispose de l'un des secteurs avicoles à la croissance la plus dynamique en Afrique de l'Ouest. Cette expansion est portée par une demande croissante en protéines animales accessibles, une urbanisation soutenue, l'émergence progressive d'une classe moyenne, ainsi qu'un engagement politique en faveur de l'autosuffisance et de la souveraineté alimentaire. Au cours des dernières années, cette dynamique s'est traduite par une augmentation significative des besoins en ingrédients destinés à l'alimentation animale, parallèlement à une hausse des volumes de fumier avicole produits.

Cependant, la filière demeure confrontée à plusieurs défis structurels, notamment le coût élevé de l'alimentation animale et une forte dépendance aux importations d'intrants, en particulier le maïs et le soja. Le maïs, ingrédient stratégique pour l'alimentation humaine et animale, fait l'objet d'une pression croissante sur les marchés. Par ailleurs, la production agricole nationale reste fortement dépendante des engrais chimiques importés, avec des rendements encore limités, notamment dans la culture du maïs, et une dégradation progressive de la fertilité des sols. Dans ce contexte, ces défis offrent également des opportunités pour le développement de solutions d'économie circulaire visant à optimiser l'utilisation des ressources, à réduire les impacts environnementaux et à générer une valeur ajoutée durable au sein de la chaîne de valeur avicole.

C'est dans cette optique que le Netherlands Food Partnership (NFP), en collaboration avec l'Ambassade du Royaume des Pays-Bas à Abidjan, a commandité la présente étude afin d'évaluer la viabilité économique de plusieurs opportunités d'affaires circulaires dans la filière avicole ivoirienne.

L'étude repose sur une approche méthodologique combinant des recherches documentaires, des visites de terrain, des entretiens avec les parties prenantes, ainsi qu'une enquête menée auprès des principaux acteurs des filières avicole, de l'alimentation animale, du manioc, des engrais et de l'agriculture. Sur la base des consultations menées, l'analyse s'est concentrée sur trois catégories de produits présentant un fort potentiel de valorisation des flux de déchets en solutions économiquement viables :

- les engrais organiques issus du fumier avicole ;
- les produits dérivés d'épluchures de manioc de haute qualité (HQCP – High-Quality Cassava Peel) destinés à l'alimentation animale ;
- les produits issus de la mouche soldat noire (BSF – Black Soldier Fly).

Les résultats de l'analyse indiquent que les engrais organiques et les produits HQCP constituent, à ce stade, les opportunités commerciales les plus prometteuses.

La production de **fumier avicole** représente une ressource abondante mais encore sous-exploitée, pouvant être valorisée sous forme d'engrais organiques à forte valeur ajoutée. Dans un contexte marqué par la dégradation des sols, l'augmentation du coût des engrais chimiques et une transition vers des pratiques agricoles plus durables, les conditions de marché apparaissent favorables. Toutefois, le développement de ce segment dépendra de facteurs clés tels que la qualité et la régularité des produits, la standardisation des teneurs en nutriments, la sensibilisation des producteurs agricoles, ainsi que la structuration de réseaux de distribution performants. La viabilité économique reposera également sur la sécurisation des débouchés, la fiabilité des infrastructures énergétiques, la disponibilité des matières premières et des mécanismes de financement adaptés.

Les produits **HQCP** offrent, quant à eux, une opportunité stratégique de substitution partielle du maïs dans l'alimentation animale, contribuant à atténuer l'un des principaux postes de coûts de la filière avicole. La disponibilité abondante du manioc en Côte d'Ivoire constitue un avantage comparatif important. Toutefois, bien que les épluchures séchées soient actuellement les plus facilement commercialisables, leur modèle économique reste non-viable dans les conditions actuelles en raison des coûts élevés de la matière première et du transport. En revanche, les produits HQCP, notamment les farines fines, présentent un potentiel de développement significatif à moyen terme, renforcé par leur adéquation aux besoins du marché et la validation technique par l'International Livestock Research Institute (ILRI).

En ce qui concerne la **mouche soldat noire**, l'analyse met en évidence un environnement commercial plus contraint. Bien que les larves présentent un fort potentiel en tant que source alternative de protéines, leur viabilité à court terme est limitée par des coûts de production élevés, une acceptation encore faible du marché et des incertitudes réglementaires. À l'inverse, le frass de BSF apparaît comme une opportunité plus immédiate, en tant qu'amendement organique, bien que la demande reste encore émergente. Il est donc recommandé de positionner le frass comme le produit commercial central d'un projet pilote.

Sur la base de ces résultats, l'étude recommande la mise en œuvre d'une phase pilote visant à tester la faisabilité technique et commerciale des deux produits les plus prometteurs : les produits dérivés d'épluchures de manioc et les engrais organiques granulés issus du fumier avicole.

Le pilote **HQCP** viserait un lot de production dans la gamme de 50 tonnes d'épluchures de manioc lavées et séchées ainsi que de farine fine de manioc, avec une durée de conservation de 4 à 6 mois. Cette activité serait portée par FOANI en partenariat avec Koudijs/De Heus et devra répondre à des critères stricts de qualité (matière sèche ≥ 88 %, matières étrangères ≤ 0,5 %, aflatoxines < 18–20 ppb, cyanure 35 ppm).

Le pilote relatif aux **engrais organiques** viserait une production de 5 à 10 tonnes d'engrais granulés à partir de fumier composté, avec une formulation de type NPK 3-3-3 ou 4-3-3 enrichie en micronutriments, une teneur en matière organique comprise entre 50 et 65 %, et une matière sèche d'environ 90 %. Les partenaires potentiels incluent FOANI, BioAni et LONO.

Ces projets pilotes permettront d'évaluer les coûts de production, la qualité des produits, la performance des technologies et l'acceptation du marché, tout en servant de vitrines pour démontrer les bénéfices des solutions proposées auprès des acteurs publics et privés.

En complément, un plaidoyer politique structuré, des actions de sensibilisation et des concertations sectorielles seront essentiels pour soutenir l'adoption de ces solutions. Ces efforts contribueront à améliorer la compréhension des bénéfices agronomiques et économiques des produits, à renforcer la confiance des acteurs et à favoriser leur adoption à grande échelle.

Le déploiement à grande échelle de ces deux solutions d'économie circulaire exige un dialogue politique approfondi et soutenu, une sensibilisation accrue et des consultations sectorielles. Concernant les engrais organiques de haute qualité, l'accent est mis sur la promotion des valeurs nutritionnelles et économiques de ce flux résiduel. Pour les engrais organiques traités et transformés, un plaidoyer constant et persistant est indispensable pour garantir leur acceptation par le secteur avicole, notamment pour l'épandage sur les cultures dans les zones d'élevage.

L'objectif final est de garantir que toutes les parties prenantes soient informées de la productivité, des avantages et de la valeur économique de ces deux solutions d'économie circulaire. Cela permettra d'instaurer la confiance et d'encourager une adoption plus large de ces deux produits.

Executive summary

Côte d'Ivoire has one of the fastest-growing poultry sectors in West Africa, driven by rising demand for affordable animal protein, rapid urbanization, a growing middle class and a national policy committed to self-sufficiency and food sovereignty. The sector has experienced significant expansion in recent years, resulting in increased demand for feed ingredients and growing volumes of poultry manure.

At the same time, the poultry sector continues to face challenges related to feed costs, dependence on imported feed ingredients, specifically soy and maize. Imported Maize is a vital ingredient for food and poultry feed. Domestic cultivation is dependent on imported chemical fertilizers and is challenged with low yields in maize cultivation and declining soil fertility. These dynamics create a strong business case for circular economy solutions that can improve resource efficiency, reduce environmental impacts, and generate additional value across the poultry value chain.

Against this backdrop, the Netherlands Food Partnership (NFP), in collaboration with the Netherlands Embassy in Abidjan, commissioned this study to assess the business viability of selected circular business opportunities within Côte d'Ivoire's poultry sector.
Based on earlier dialogues with stakeholders, the study evaluates three product categories with the potential to transform waste streams into commercially viable products: Organic fertilizer derived from poultry manure, High-Quality Cassava Peel (HQCP) products for animal feed, and Black Soldier Fly (BSF) products.

The business viability analysis part of this study indicates that organic fertilizer and HQCP products present the most promising commercial opportunities.

Poultry manure is generated in substantial quantities across the country and represents an underutilized resource that can be converted into valuable organic fertilizer products. Growing concerns around soil degradation, increasing fertilizer costs, and interest in sustainable agricultural practices create favorable market conditions for both compost and higher-value organic fertilizers. However, success will depend on product quality, nutrient standardization, farmer awareness, and effective distribution networks. The business model viability is dependent upon market security, reliable energy infrastructure, consistent supply of raw material, and the financing structure.

HQCP products offer a compelling opportunity to partially substitute maize in animal feed formulations, addressing one of the poultry sector's most significant cost drivers. Côte d'Ivoire's large cassava production base provides an abundant and locally available raw material, while feed manufacturers continue to seek cost-effective alternatives to conventional feed ingredients. Although dried cassava peels currently represent the most commercially feasible product due to existing processing and blending infrastructure, this model is not viable under current conditions and is operating at a loss due to the high price of feedstock and transportation. Therefore HQCP mash products, particularly fine mash products, demonstrate strong potential for future market development because of their suitability for poultry and livestock feed applications. The local acceptance of dried cassava peels as a feed and the application of localized technology and product concept validated by the International Livestock Research Institute (ILRI) further strengthens this business case.

The assessment of **Black Soldier Fly products** highlights a more challenging business environment. While BSF larvae have the potential to provide a sustainable alternative protein source for animal feed, current production economics, market acceptance, and regulatory uncertainties limit their immediate commercial viability. In contrast, BSF frass shows greater near-term potential as an organic soil amendment, although market demand remains less developed than for conventional organic fertilizer products. It is therefore recommended to position frass as the core commercial product for a pilot project.

The study is based on a combination of desk research, field visits, stakeholder interviews, and a survey conducted with key actors across the poultry, feed, cassava, fertilizer, and agricultural sectors. The findings suggest that circular economy solutions can play an important role in strengthening the competitiveness and sustainability of Côte d'Ivoire's poultry industry. By converting agricultural by-products and waste streams into productive inputs, these business models can contribute to lower feed costs, improved soil health, reduced environmental impacts, and new income-generating opportunities for entrepreneurs and farmers.

Based on these findings, the study recommends a pilot phase focused on validating the technical and commercial viability of the two most promising product streams: High-Quality Cassava Peel and mash (HQCP) and pelletized organic fertilizer derived from composted and treated poultry manure. The pilot will assess production costs, product quality, processing technologies, and market acceptance while generating practical insights for future scale-up.

For **HQCP**, the pilot will focus on a production batch in the range of 50 tons of washed, dried cassava peels and dried fine cassava mash with an extended shelf life of 4-6months, potentially led by FOANI and Koudijs/De Heus. The finished product should have a minimum of 88% dry matter, 0.5% maximum foreign matter and aflatoxin (18-20PP) and cyanide (35ppm) well below permissible levels.

For **organic fertilizer**, the pilot will potentially produce 5–10 tons of pelletized fertilizer from composted and treated poultry manure, targeting a nutrient profile of NPK 3-3-3 or 4-3-3, with micronutrients, 50-65% of organic matter, fulvic and humic acids. This has 90% dry matter and is efficient to transport and apply. Potential production partners include FOANI, BioAni, and LONO. A detailed feasibility assessment(s) will evaluate the most appropriate processing technologies suited to the (available raw material quantities, quality and geographical location) local context.

Both pilots will also provide a platform to demonstrate production processes and product performance to private sector stakeholders, farmers, and policymakers, helping to build market confidence and inform future investments in circular economy solutions within Côte d'Ivoire's poultry sector.

Scaling both circular solutions requires extensive and sustained policy dialogue, awareness creation and sectoral consultations. For HQCP, the focus is on promoting nutritional and economic values of this residual stream. For treated and processed organic fertilizers advocacy must be consistent and persistent to ensure acceptance of use by the poultry sector, especially in crop application in poultry producing areas.

The ultimate goal is to ensure all stakeholders are informed on the productivity, benefits, and economic value of both circular solutions. This will build trust and encourage wider adoption of both products.

1 Introduction

Côte d’Ivoire has one of the fastest-growing poultry sectors in West Africa, driven by rising demand for affordable protein, rapid urbanization, a growing middle class, and government policies that protect local production. The sector’s expansion has increased demand for feed ingredients and generates growing volumes of poultry manure and other organic by-products, creating opportunities for circular economy solutions (NABC, 2020).

Against this backdrop, the Netherlands Food Partnership, with its central mission of building strong partnerships for sustainable food systems, in close collaboration with the Netherlands Embassy in Abidjan, commissioned this study.

The study assesses the business viability of circular solutions in the poultry value chain in Cote D’Ivoire with a focus on three product categories: Organic fertilizer from poultry manure, High-Quality Cassava Peel (HQCP), and Black Soldier Fly (BSF) products which have the potential to improve resource efficiency, reduce waste, and create additional value within the poultry value chain.
The three product categories covered in this report are defined as follows:

- **Compost/Organic fertilizer-** In this study, we refer to organic fertilizers with the feedstock of 100% poultry manure. Compost refers to biologically decomposed organic materials, including poultry manure, used primarily as a soil amendment to improve soil health, organic matter, and water retention. Organic fertilizer refers to a more highly processed product derived from nutrient-rich organic materials, such as poultry manure, that is designed to deliver nutrients in a concentrated and standardized form. This distinction is important from both a regulatory and market perspective, as product standards, labeling requirements, and commercial value differ significantly between the two categories.
- **High-Quality Cassava Peel (HQCP) products** encompass a range of processed cassava peel products, including dried peels, whole mash, coarse mash, and fine mash, as a partial replacement for maize. While the current market focus in Côte d'Ivoire (by Koudijs/De Heus due to their existing blending infrastructure) is on dried cassava peels, fine mash has been identified as a particularly attractive option for poultry feed and other livestock feed applications.
- **Black Soldier Fly Larva (BSFL) products** include both black soldier fly larvae and frass. BSFL is a protein-rich feed ingredient that can potentially partially replace conventional protein sources in animal feed. BSF frass is the residual material generated during the rearing of BSFL. Based on the feedstock it is rich in organic matter and minimal nutrients, frass is primarily used as an organic soil amendment or fertilizer (FAO, 2023). Despite its potential, its commercial viability appears limited under current market conditions in Côte d'Ivoire. Consequently, this report focuses primarily on composted poultry manure integrated with FBSF frass as the core commercial product.

The business viability of these three products is evaluated based on a combination of desk research, field research, survey, and interviews with key actors in the poultry sector.

2 Market Potential Assessment

2.1 High Quality Cassava Peel (HQCP):

Analysis of market demand and supply:

Within the Côte d'Ivoire context, maize is the primary source of poultry feed, and a staple food in the country. The demand for maize is set to grow by 1.7% annually, reaching 789,000 tons by 2026. The consumption of maize in 2025 was 712,000 metric tons(Report Linker, 2022). The demand for maize is structurally high and increasing, yet domestic production remains insufficient to meet total demand, resulting in recurring supply gaps and price fluctuations, particularly during lean seasons (FAO, 2024). This creates a strong incentive for feed producers to diversify their raw material base, reduce costs and reliance on maize: these concerns were verified in interviews with FOANI and Koudijs/De Heus.

In parallel, cassava represents a strategic and abundant resource. Côte d'Ivoire is one of the largest cassava producers in West Africa, with annual production estimated at over 6–7 million metric tons (FAOSTAT, 2023; National agricultural statistics). Cassava processing, particularly for products such as *Attiéké and Garri*, generates substantial volumes of peels, typically representing 15–20% of the root weight (ILRI, 2025), translating into over a million tons of cassava peels annually. Currently, these residues are largely underutilized or discarded, representing both an environmental burden and a missed economic opportunity. Traditionally the peels are dried and sold cheaply and in limited quantities for animal feed, with the risk of cyanide and aflatoxin poisoning.

High-Quality Cassava Peel (HQCP) is distinguished from raw fresh peels due to the processing - sorting to remove woody parts and foreign matter, grinding, fermentation, dewatering/detoxification (cyanide reduction), sieving and controlled drying, giving longer shelf life of 4-6months compared to fresh peels that rot within 24hours. HQCP offers a viable alternative energy ingredient in animal feed. Nutritionally, HQCP provides comparable metabolizable energy to maize, although it is lower in protein, making it suitable as a partial replacement up to 28-30% in feed formulations balanced with protein sources. In addition, fermentation improves poultry gut health and digestion (ILRI, 2025).

Waste stream mapping:

According to the Africa Agriculture Watch 2023 forecasts (Ndoye et al., 2023) and field research, the highest concentrations of cassava residues are found in the following areas (see annex 1 for cassava production map):

- Azito Village (Yopougon)
- Dabou
- Bingerville and Bonoua
- Abidjan District periphery: The broader Abidjan region is characterized as a top-producing area, with around 119,000 metric tons of cassava produced in the district in 2023, translating to a high volume of peels.

The proximity of HQCP production area to cassava processing infrastructure is critical for access to **fresh** raw material and reduces the barriers to entry for this business, making it affordable for the women already in the production of *Attieke, Garri* and other human consumable products from the cassava tuber.

Pricing benchmarks, competitive analysis, and growth outlook:

The information presented on the table is based on Koudijs/De Heus annual demand for dried peels. FOANI's current demand for maize per annum is 10,000-15,000 tons and expanded production demand is estimated at 21,000-30,000 tons per annum. Potentially 20-30% of this demand can be replaced by HQCP mash.

Table 1. Cost comparison table HQCP

	HQCP (whole)	HQCP (fine)	HQCP (coarse)	Maize (imported)	Maize (locally produced)
Starch (%)	66.7	69	55	68.8	68.8
Protein (%)	2.5	2.6	2.8	8.8	8.8
Fat (%)	1.4	1.2	1.2	4.1	4.1
Crude fiber (%)	9.8	8.2	15.6	2.6	2.6
Crude ash (%)	5.8	6.6	3.5	1.4	1.4
Total energy (kcal/kg DM)	2947	3039	2495	3840	3840
Price in CFA /ton cassava peel (paid by Koudijs/De Heus)	90,000	NA	NA	90-130,000	10-20,000
Price/ton (EUR)*	137			457	206

Table based on assumptions from Okike et al., 2022 and 2026 prices provided by De Hees and FOANI
*prices in EURO rounded to the nearest whole number.

Table 2. Supply and demand of Cassava peels

	Current quantity (tons per annum)	Future Quantity (tons per annum)
Poultry feed production capacity	20,000 (Koudijs/De Heus Abidjan factory)	60,000 (Abidjan + new Korhogo factory)
Maize demand	150,000	450,000
Local maize supply	10,000–20,000	Significant supply gap expected to remain
Fresh, washed, dry, cassava peel demand (83% dry matter, 0.5% maximum foreign matter)	50 tons per month (minimum)	Expected to increase with expansion of feed production
Fresh, washed, dry cassava peel supply (83% dry matter, 0.5% maximum foreign matter)	60-120	Insufficient to meet current and future demand
Market opportunity	Deficit of 130,000–140,000 tons/year maize and 480–540-tons/year cassava peels	Strong opportunity for increased HQCP production, collection, and processing of feed ingredients

* Table based on 2026 information provided by Koudijs/De Heus: cassava peel data converted from monthly figures: demand of 50 t/month = 600 t/year; supply of 5–10 t/month = 60–120 t/year.

The economic case for HQCP as a partial replacement for maize is particularly compelling. Cassava peels are low-cost or near-zero-cost raw materials, even after processing, HQCP can be significantly cheaper than maize on a per-ton basis, especially in contexts of high maize price volatility. This creates a clear opportunity for feed millers and poultry producers to reduce feed costs and improve margins. Cassava peels represent a non-food biomass, reducing competition between food and feed and contributing to more efficient resource use (ILRI, 2025). Sun drying of the cassava peels requires no energy investment, offering low entry costs (Okike et al., 2022), opens up a new industry and creates new employment opportunities, especially for women.

Despite these advantages, the HQCP market in Côte d'Ivoire remains underdeveloped. Key market adoption constraints include the lack of awareness, lack of regulatory standards for cassava-based feed ingredients, and quality control, particularly regarding moisture levels, high costs of drying technology, inadequate storage infrastructure, unchecked cyanide content, which are critical for feed safety (ILRI, 2025). In addition, cassava bacterial blight and mosaic disease, low yields and a fragmented supply chain with logistical challenges, linked to the dispersed nature of cassava processing, can limit consistent feedstock supply. The negative perceptions of peels as waste and limited interest among Garri and Attiéké producers present significant challenges.

2.2 Manure/compost/Organic fertilizer:

Analysis of market demand and supply:

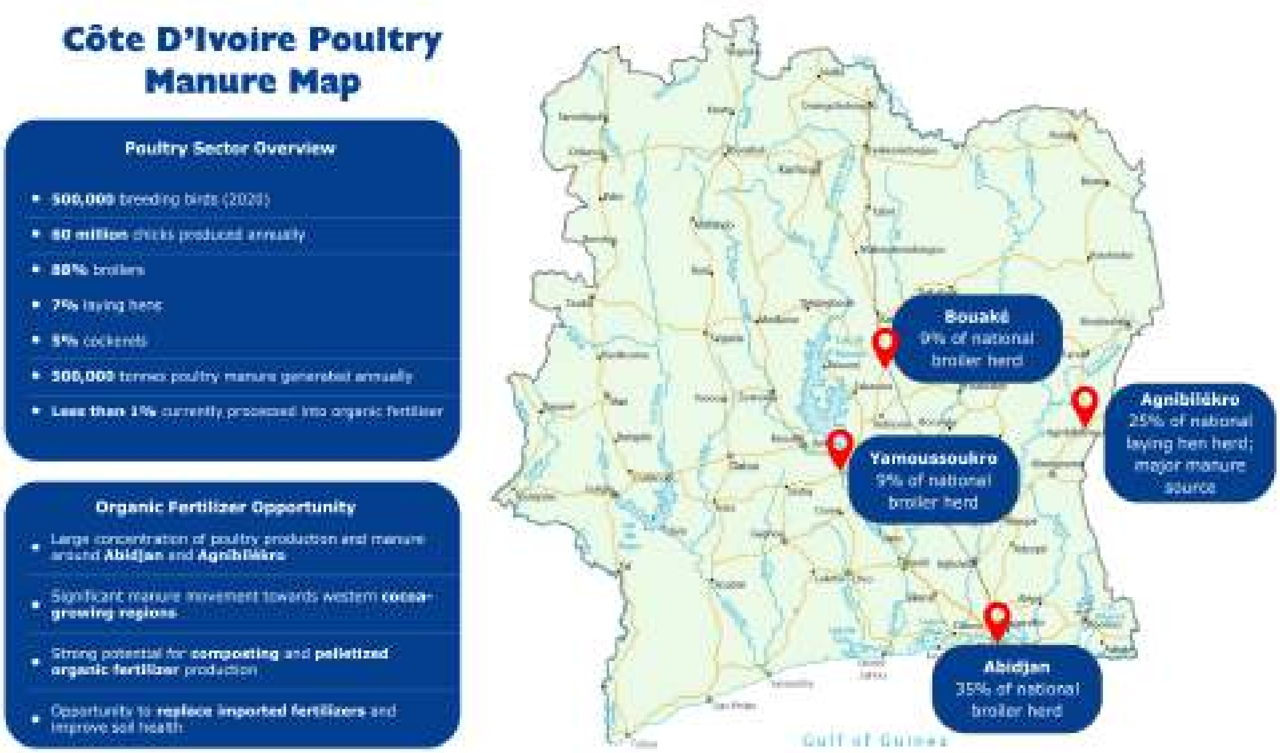
Demand for fertilizer in Côte d'Ivoire is increasing, while local production remains limited. The country imported 613,527 metric tons of chemical fertilizers in 2023 (IFDC, 2024), highlighting its continued dependence on external supply. At the same time, soil degradation, declining productivity, and climate variability are affecting key agricultural sectors, including cocoa, cashew, and staple crops. These challenges are driving interest in organic soil amendments that improve soil health, water retention, and long-term resilience. Rising mineral fertilizer prices have further increased farmer interest in compost and organic fertilizers.

Recent global disruptions, including the COVID-19 pandemic, the Russia–Ukraine war, and instability around the Strait of Hormuz, have constrained fertilizer imports and increased costs. In January 2026, chemical fertilizers became subject to a 9% VAT, further reducing affordability (African Agribusiness, 2026). Therefore, locally produced compost and organic fertilizers derived from poultry manure offer an affordable and accessible alternative, particularly for smallholder farmers. Demand for compost is strongest among cocoa farmers, although uptake is affected by fluctuations in cocoa prices; current low prices have reduced farmer spending on inputs (Huanda Cocoa Team, 2026; LONO).

On the supply side, Côte d'Ivoire's poultry sector generates more than 500,000 tons of manure annually, yet only about 1% is converted into compost or organic fertilizer (RVO, 2025). Poultry litter is rich in nutrients, organic matter, and humic substances, making it a valuable feedstock for compost and organic fertilizer production (Agriculture Institute, 2023). However, manure (fresh and un-composted fresh manure and manure mixed with litter and feathers) is often applied directly to fields or traded informally at low prices, limiting value creation and creating environmental risks (soil and water bodies) (RVO sector analyses, 2023–2025). This provides a significant opportunity to convert an abundant waste stream into higher-value agricultural inputs (Coulibaly, 2026).

Waste stream mapping:

Côte d'Ivoire's modern poultry sector has grown steadily in recent years. Production is characterized by farms of varying sizes: broiler farming is dominated by medium-sized operations of 3,000–6,000 birds per batch (45% of farms), while egg production is mainly carried out on small farms with fewer than 2,000 birds (52% of farms). Large-scale operations are relatively rare, representing only 2% of broiler farms and 1% of layer farms, and are concentrated in the Abidjan and Agnibilékro regions, respectively (RVO, 2025).



Source: based on RVO (2025)

Pricing benchmarks, competitive analysis, and growth outlook:

The current market price of compost ranges from 5,000 to 15,000 CFA per 50 kg (2025), while chemical fertilizers cost approximately 20,000 CFA per 15–25 kg, making compost and organic fertilizers highly competitive alternatives.

Fertilizer demand is distributed across several crop sectors: cotton (46%), palm oil (16%), cocoa (16%), and subsistence crops (9%) (Giordano et al., 2018). However, current local compost production is only about 12,000 tons, creating a significant growth opportunity for increased domestic production of organic fertilizers.

In this report we distinguish between compost, composting, and organic fertilizer.
Compost is a finished product that is made up of plant-based material, high moisture content and varied nutrient and organic matter content due to the varied sources of raw material and could be combined with 10-30% of poultry manure. The end product is unstable with varied nutrient and organic matter content and inefficient to transport and apply on the field.
Composting- is the process of breaking down raw material – either plant or manure based.
Organic fertilizer from poultry manure (combined broiler and layer litter)-is a nutrient and organic matter dense material that is treated, dried (90% dry matter) and processed into pellets or granules and easier to transport and apply.

A key barrier is the perception that manure-based products (whether treated or not) pose biosecurity risks, limiting the adoption of properly composted and utilization of treated manure in poultry production areas. Establishing stringent processing standards and quality assurance systems will therefore be critical to build trust in finished products. Although poultry manure is abundant and demand for affordable soil amendments is growing, the sector remains underdeveloped. Weak collection and distribution systems, limited processing capacity, the absence of quality standards, and high transport costs constrain market growth. Both supply and demand are already present. The primary opportunity lies in organizing and upgrading the existing market through improved collection systems, standardized production, quality assurance, and stronger market linkages.

2.3 Black Soldier Fly Larva (BSFL):

BSF larvae meal can partially replace conventional protein sources in animal feed, with inclusion rates of 10–30% maintaining comparable animal performance and feed efficiency (MDPI, 2020). The global BSFL market is expected to grow significantly, driven by its potential to substitute for soybean and fish meal. In addition, BSF frass offers a lower-risk by-product with promising commercial applications as an organic fertilizer. Despite this potential, research and development, commercial supply and demand for BSF larvae remains limited. Feed millers report that BSFL are not yet price-competitive compared with conventional feed ingredients. This is largely due to the high costs associated with waste collection, sorting, and processing (FAO, 2023). Market growth is further constrained by underdeveloped regulations for insect-based proteins and the strong market position of established feed ingredients such as soybean meal.

The use of poultry manure as a BSFL substrate presents additional challenges, including potential contamination from pathogens, heavy metals, antibiotic residues, and Salmonella (Abdel Maksoud et al., 2026). BSF larvae also requires a balanced mix of organic waste streams, as poultry manure alone does not support optimal growth. While BSF offers strong long-term potential as a sustainable protein source, challenges related to cost, biosecurity, regulation, market acceptance, and scaling must be addressed before widespread promotion and adoption can occur.

3. Business Viability

3. 1 High Quality Cassava Peel (HQCP): (see annex 2 for the full financial analysis)

This analysis evaluates the financial viability of producing dried cassava peels as a feed ingredient or processing input for Côte d'Ivoire's poultry value chain, based on real operational data from Koudijs/De Heus' suppliers. The model assesses the full cost structure for producing one metric ton of dried product and tests profitability under multiple operational scenarios.

> Key finding: The model is not viable under current conditions, generating a loss of CFAF 28,295/t (−23.9%), with costs exceeding the market price. Costs are highly concentrated, with feedstock (56.4%) and transport (32.4%) totaling 89%. High moisture content (~70%~) makes long-distance transport inefficient, as most of the cost is tied to moving water rather than usable material.

Free or near-free feedstock is the main driver of profitability, shifting the model to a +74.3% margin and confirming it as the key viability lever. The optimal setup (free feedstock with local processing and no transport) yields very high margins (+576.9%), while even partial cost reductions are sufficient to restore profitability (+36.8%).

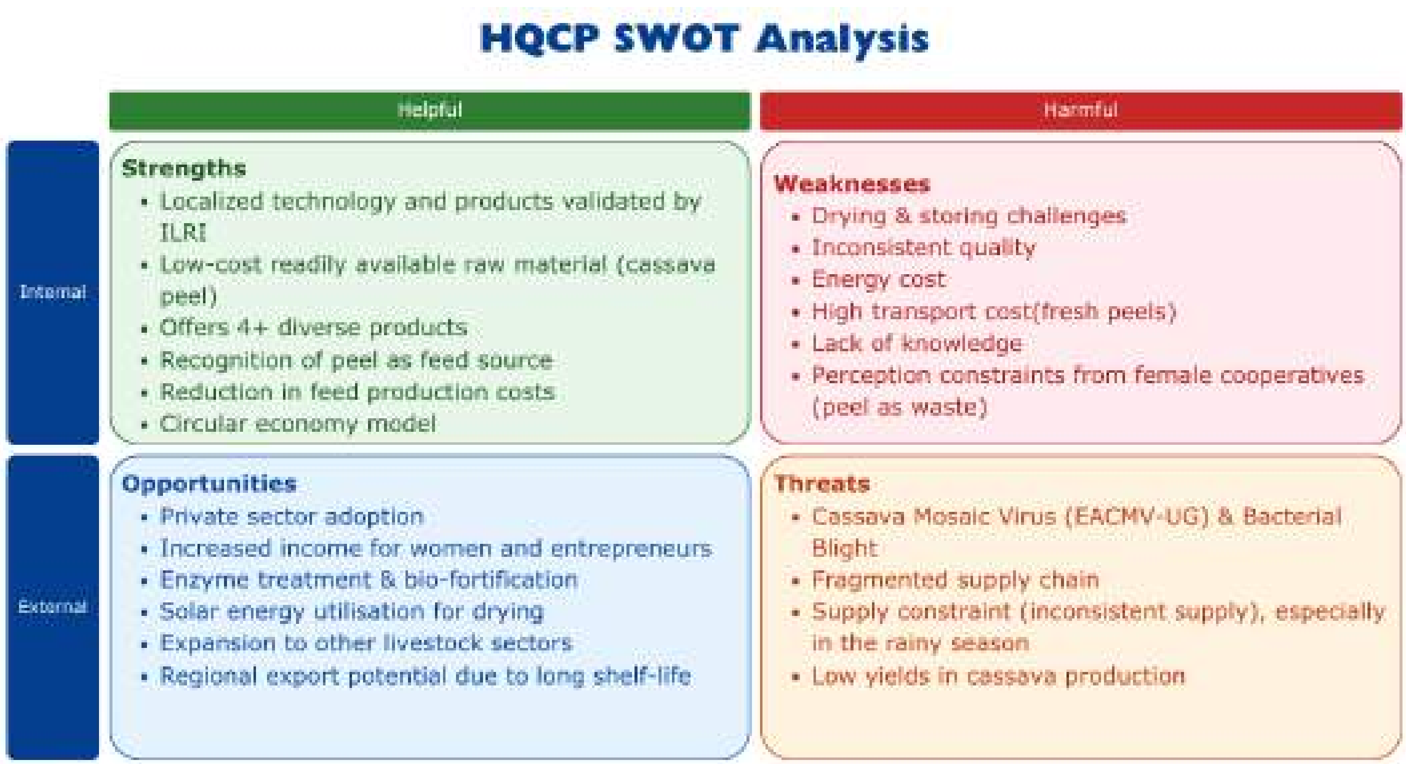
The current break-even (CFAF 118,295/t) is well above market price, confirming unviability. With free feedstock, it drops to CFAF 51,628/t, ensuring strong viability.
Viability depends on zero-lower cost feedstock, localized processing, and reduced logistics costs. Key risks include limited demand and cassava seasonality, both of which must be validated before scaling.

Based on the analysis, the following recommendations are proposed to support the implementation of a viable pilot project:

- Establish formal arrangements with cassava processing units (e.g., Attieke, Garri) to obtain cassava peels at no cost. As these residues are typically treated as waste, such agreements are both feasible and essential to achieving economic viability.
- Locate the drying unit within close proximity (preferably within a 5 km radius) of high-density cassava processing clusters to eliminate or significantly reduce transportation costs (a major cost driver). Refer to map in Annex 1.
- Consider the use of mobile or semi-permanent drying units that can be relocated in line with cassava harvesting cycles. This approach enables continuous access to fresh feed stock while minimizing logistics constraints.
- Systematically assess and document cassava peel availability in terms of volumes, seasonality, and geographic distribution.
- Assess the demand for both dried cassava peels and cassava mash, while incorporating the requirements of Koudijs/De Heus, FOANI, and other potential buyers to identify the most viable and scalable market opportunity.
- The ILRI recommendation of processing the mash must be compared to peel processing in a pilot to establish efficiency and viability in the local context.

Koudijs/De Heus only uses peels based on their existing infrastructure. The market potential and demand could be for mash, which according to ILRI research is the most recommended and viable.

- Implement a small-scale pilot based on localized processing with zero-cost feedstock prior to any large-scale capital investment. This will allow for empirical validation of cost assumptions, operational performance, and drying yield parameters under real conditions.
- Pilot the production of HQCP mash in comparison to dried cassava peels to analyze economic viability and efficiency, since the mechanical pressing of the grated peels reduces moisture content (and cyanide levels from 400ppm to 35ppm) from 70% to 32-48%; thereby reducing drying days from 5 to 2-3 days. Storage is also improved due to the less bulky final product in comparison to dried peels.



3. 2 Organic fertilizer (see annex 3 for the full financial analysis):

This analysis evaluates the financial viability of processing poultry manure into organic fertilizer in Côte d'Ivoire, comparing two models: a cooperative model (100 tons/month, CAPEX: XOF 76.6 million) and a semi-industrial model with a SHONG 3 t/h pelletizing line (500 tons/month, CAPEX: XOF 356.2 million). It incorporates detailed CAPEX from supplier quotations, a comprehensive OPEX structure, a mixed revenue model (bulk and bagged sales), and five-year profit and loss projections.

> Key finding: the semi-industrial model outperforms the cooperative model across all key financial indicators. It achieves an IRR of 74.3%, an NPV of XOF 1.54 billion at an 8% discount rate, and a 3.5-year payback period under full commercialization, making it a highly attractive investment. By contrast, the cooperative model has an 11-year payback period and generates negative net profit in Year 1, limiting its bankability without grant support.

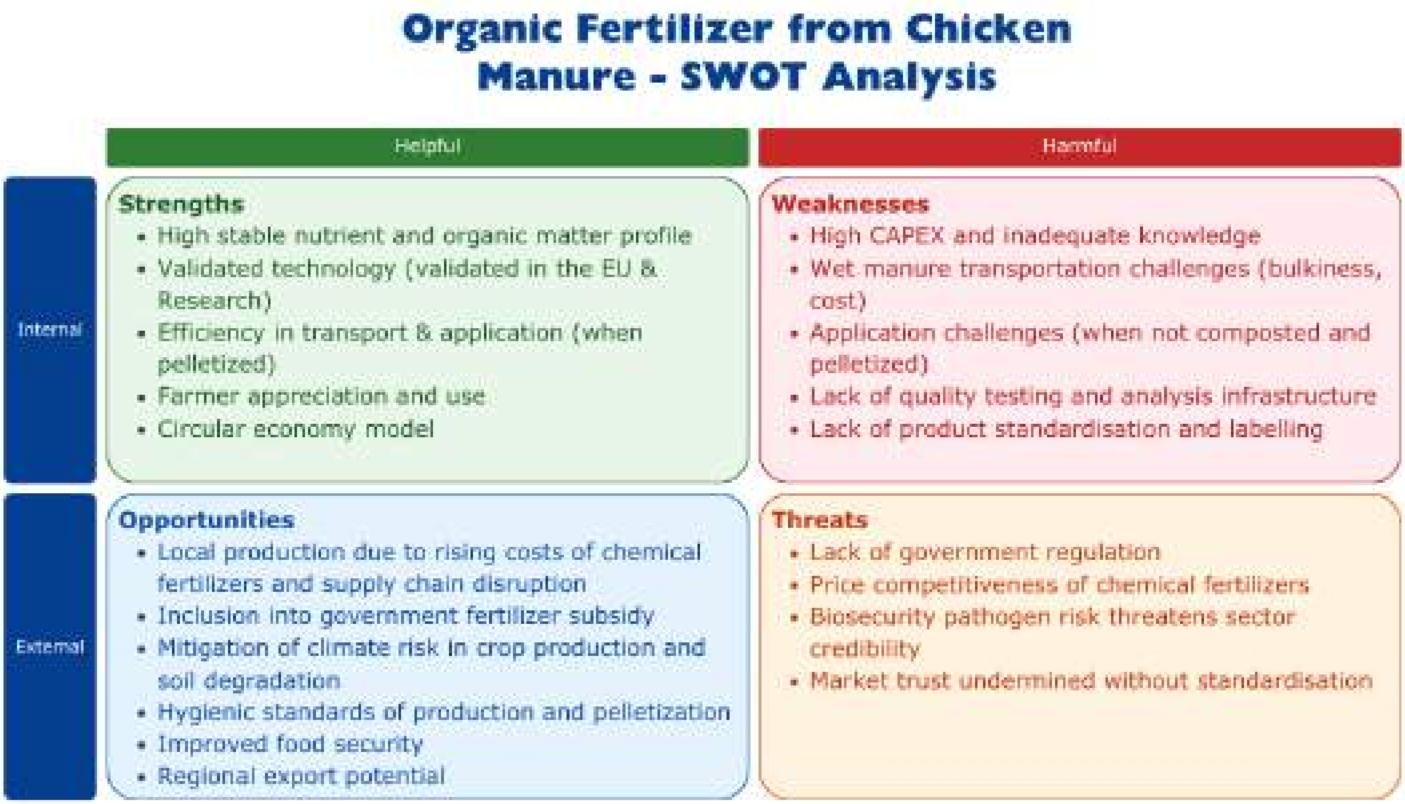
However, this strong performance relies on full commercialization from Year 1. Sensitivity analysis (60%, 75%, and 100% scenarios) shows that even at 60%, the semi-industrial model remains near EBITDA break-even, while the cooperative model operates at a deficit. The key issue, therefore, is not the financial viability of production, but the ability to secure sufficient market demand to justify the investment.

On the other hand, FOANI Company has access to 100,000 tons of raw material annually, a volume that far exceeds the processing capacities considered under both the cooperative and semi-industrial business models. Consequently, a separate analysis will be undertaken to assess the implications of this resource availability and explore larger-scale development scenarios that go beyond the scope of the current business models. Given the secure feedstock supply, we recommend implementing the pilot phase at FOANI. In addition to reducing supply risk, FOANI’s proximity to the Ghanaian border provides access to both the Ivorian and Ghanaian markets, the latter being significantly larger. For comparison, the combined annual production of major compost producers in Côte d’Ivoire (Elephant Vert, LONO, and BioANI) is estimated at 12,000 tons, underscoring the scale of FOANI’s growth potential. At the same time, annual organic fertilizer consumption was approximately 32,000 tons, of which 20,000 tons were imported.

Project viability depends on four interdependent factors:

- Market security is critical: achieving at least 75% commercialization in Year 1 requires pre-secured offtake agreements with cocoa cooperatives, industrial plantations (cashew, rubber, oil pam, cocoa- including Brong Ahafo region in Ghana) or agricultural input distributors. These commercial arrangements should be in place prior to construction.
- The financial structure should combine debt financing (approximately 50% at 11%, through institutions such as BNI or BOAD) with equity and/or grant funding.
- Reliable energy infrastructure is essential to support the pelletizing line, given its installed capacity exceeding 100 kW.
- The supply chain must ensure consistent access to approximately 500 tons of raw material per month, secured through contractual arrangements with other medium-scale poultry producers.

Three priority actions are recommended for NFP/EKN. First, conduct a quantitative market assessment targeting cooperatives, plantations, and distributors to validate demand volumes and preferred distribution channels. Second, initiate discussions with financial institutions (BNI, BOAD, FDFP) to structure an appropriate financing package based on the findings of this analysis. Third, finalize site selection and obtain detailed quotations from local contractors for key infrastructure components—including the concrete platform, storage warehouse, and electrical connection—to further refine CAPEX estimates.



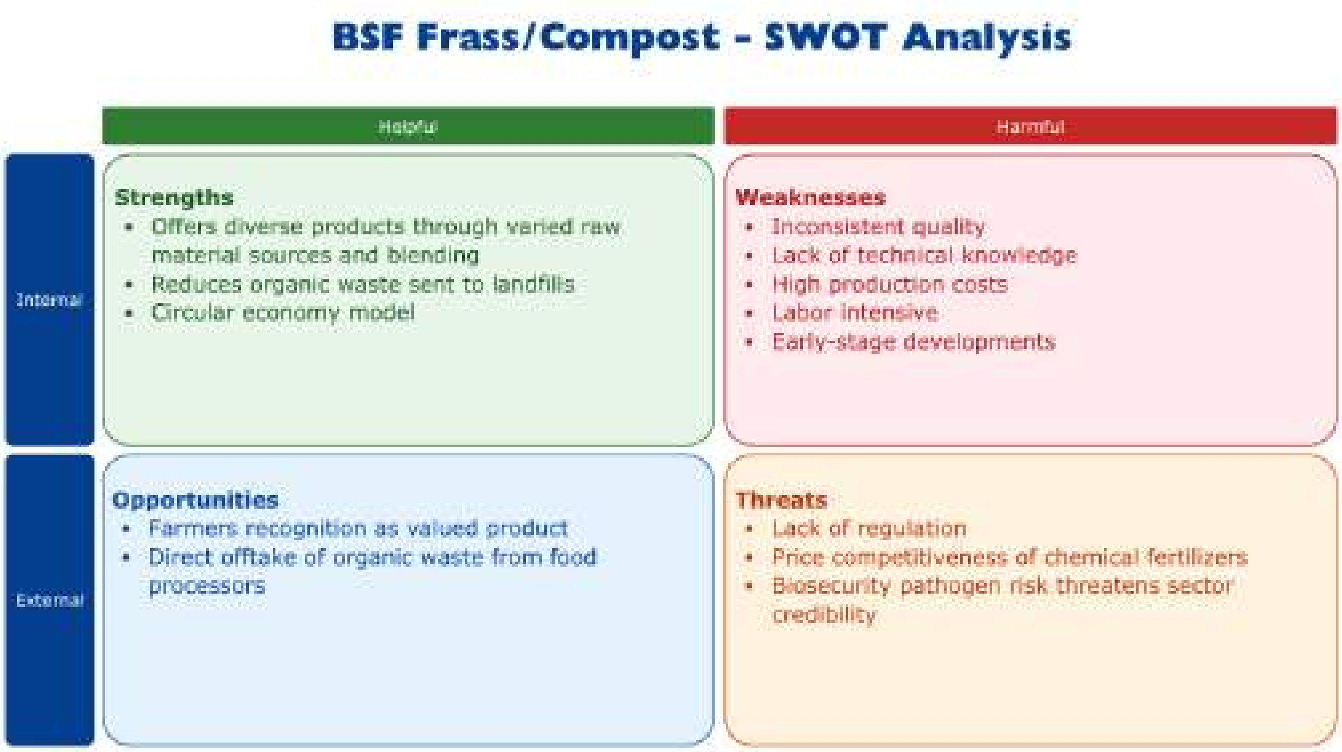
3.3 Black Soldier Fly (BSFL) Compost improved with Poultry manure: (see annex 4 for the full financial analysis)

> The key finding is that frass constitutes the dominant revenue stream in both models (semi-industrial and cooperative), accounting for approximately 68% of total revenues, compared to 32% generated by dried larvae. This indicates that frass is the primary economic driver of these production systems. Therefore, it should be treated as the primary economic driver in investment and strategic decisions.

Recommendations:

- Prioritize the semi-industrial model for the pilot phase: frass break-even threshold (+26%) is achievable in the short term, and the associated economies of scale justify the higher upfront investment.
- Position frass as the core commercial product of the pilot: initiate immediately the processes for nutrient analysis (NPK composition), certification, and packaging prior to the start of production.
- Avoid commercializing fresh larvae during the initial phase: their very short shelf life introduces logistical and quality risks that are incompatible with the launch stage of a pilot project.

- Formalize substrate supply agreements before committing to infrastructure investments: no financial model is viable without a guaranteed, reliable supply at predictable cost.
- Conduct a market study on frass targeting vegetable producers, perennial crop farmers, and producer organizations in the main production zones around Abidjan and Yamoussoukro, in order to validate price points and market absorption capacity.
- Amortize legal and registration costs (27 million XOF) over a period of 3 to 5 years in the semi-industrial pilot's financial model, to present a more representative net result to investors and funding partners.



4. Stakeholder Readiness Assessment (pilot design and implementation)

Stakeholder readiness for pilot design and implementation was conducted through questionnaire surveys and stakeholder interviews, and the areas of their readiness is indicated in bold font.

Feed millers: Potential partners, concerns remain regarding HQCP price, quality, and consistent availability.

- FOANI / FOANI Foods / FOANI International Training College (Agnibilékrou) - Respondent: Akoua Aicha Ouattara espouse Coulibaly- **piloting HQCP mash**
- Koudijs/De Heus (Abidjan): Potential partner - **expanding washed and dried peel supply bases**.
- SONAL Société Nationale d'Alimentation SARL (Abidjan) - Respondent: Seri Pierre
- Good Feed (Abidjan) - Respondent: Konan Yao Stéphane

Cassava processors:

- GROUPE MCY ET FILS (Yamoussoukro)- Respondent: Yohou espouse Digbahi Marie Claudine- **supplier of Koudijs/De Heus**
- SCOOPS COFVCTM-BO (Aboisso)- Respondent: Alo Bobo Marie- **HQCP mash processing.**
- ADOMA PRODUCTION (Abidjan)- Respondent: Assi Apo Jacqueline-**HQCP mash processing.**
- Beracca Mastery Group (Bouaké) - Respondent: Kouadio Akoua Bérénice espouse Debrimou- **HQCP mash processing.**

Compost producers:

- BioAni (Abidjan)- **organic fertilizer production**
- LONO (Yamoussoukro)- **organic fertilizer production**
- FOANI poultry farms (Agnibilékrou) – **organic fertilizer production**

Poultry farmers:

- **Willingness to sell manure**:
    - Divine Ferme (Dabou)- respondent name: Akproines
- **Willingness to sell manure and host on-site composting unit**:
    - KOFFI (Abidjan)- respondent name Paulin
    - SOCOSAREG-LAME (Adzope)- respondent name: EMODJA KOFFI
    - Ferme Agricole HS (Agnibilékrou) - respondent name: HIMOU SOULEYMANE
    - Ferme Volaille (Toumodi)- respondent name: Yves YAO

Fish producers:

- Mafouê pisciculture (Abidjan) - respondent name: Djouman Chiayé Marie Jeanne (Germaine)- **testing casava mash in fish feed.**
-

Institutional partners

- ILRI- **train producers of HQCP mash in technology and production expertise and work with government agencies and stakeholders to include HQCP technology in nation feed policy framework.**
- CNRA (via Centre Moye)
- Félix Houphouët-Boigny University (via LONO). – **potential testing and analysis facility is available in the university.**
- Centre MOYE- **can potentially generate extra income and showcase processing technologies and cultivation practices.**
- ANADER/FIRCA (via Pevanny)
- AERES- **improve knowledge of the poultry sector.**

5. Roadmap for Pilot Implementation and Scaling

(See annex 5 for the detailed roadmap).

The pilot project will focus on validating the production costs and quality of two products.

The first product is 50 tons of High-Quality Cassava Products (HQCP), specifically dried cassava peels produced at a larger scale and **dried fine cassava mash** with a shelf life of up to six months. Production will be undertaken by FOANI and suppliers of De Heus. At the Moye center cultivation potential for improved cassava varieties and Good Agricultural Practices (GAP) and Climate Smart Agriculture practices to increase the yields of cassava and increase crop resilience against disease can be showcased to extension services officials and farmers.

The second product is 5-10 tons of **pelletized organic fertilizer** produced from poultry manure with a target nutrient profile of NPK 3-3-3 or 4-3-3, 50-65% organic matter, micronutrients and humic acids. Potential production partners include FOANI, which has access to reliable raw material sources and can establish strict production protocols for safe treatment of chicken manure, and BioAni in Abobo, who already works with poultry manure and has an established supply chain and market linkage. LONO may also pilot production in Azagui, in collaboration with FOANI, as production in Yamoussoukro is not feasible due to contractual restrictions.

As stated earlier, in this report we distinguish between compost, composting and organic fertilizer:

- **Compost** is a finished product that is made up of plant-based material, high moisture content and varied nutrient and organic matter content due to the varied sources of raw material and could be combined with 10-30% poultry manure. The end product is unstable with varied nutrient and organic matter content and inefficient to transport and apply on the field.
- **Composting**- is the process of breaking down raw material – either plant or manure based.
- **Organic fertilizer** from poultry manure (combined broiler and layer litter) is a nutrient and organic matter dense material that is treated, dried (90% dry matter) and processed into pellets or granules.

During the pilot phase, a more detailed feasibility study will be conducted to determine the most appropriate technologies and production scales for both product streams. This will include assessing processing equipment and feasible drying technologies (solar) for cassava products; and evaluating processes for composting, sterilizing, and pelletizing poultry manure to produce a safe, easy-to-transport, and easy-to-apply fertilizer product.

The result of both pilot products can be showcased to stakeholders and policy makers in the local sector and the West African region.

5.1 HQCP Roadmap for Development and Scale-Up:

Phase 1 (Years 1-2): Foundation Building

Priority actions should focus on policy advocacy, awareness creation, and market development. Awareness campaigns should target poultry, livestock, and aquaculture producers, feed millers, cassava processors, and government stakeholders to promote the nutritional and economic value of HQCP products. At the same time, HQCP should be formally recognized as a distinct feed ingredient category, supported by clear quality, safety, and labelling standards to ensure market confidence and fair pricing.

Pilot processing sites should be established in partnership with FOANI and located within 5–7.5 km of cassava processing centers to maintain profitable transport costs (ILRI, 2025).

Collaboration with research institutions such as ILRI and feed manufacturers (e.g. Koudijs/De Heus) will help validate nutrient profiles, strengthen market linkages, and develop the peel supply chains. Standardized processing protocols should maintain cyanide levels below 35ppm, and address risks associated with poor drying practices, moisture, and aflatoxin contamination. Training programs and a Training-of-Trainers framework for knowledge dissemination should be developed to equip cassava farmers, processors, and feed producers with practical skills on processing, equipment operation, hygiene, and feed safety. To ensure year-round peel availability, efforts should also promote improved cassava varieties, climate-smart cultivation practices, and collaboration with government agencies, producer associations, and development partners.

Phase 2 (Years 3-4): Scaling and Market Integration

Scaling efforts should focus on strengthening commercial viability and product quality. Financing mechanisms for processors should be linked to off-take agreements that provide predictable demand and revenue streams. Piloted solutions addressing bottle necks (like drying, storage, no contamination) from years 1-2 should be evaluated and scaled. Government enforcement of labelling and quality standards will be critical, while feed millers should be encouraged to formally declare HQCP in feed formulations to increase market confidence. Given the long shelf life of HQCP products, opportunities for regional exports to Sahelian livestock markets should also be explored. Progress should be monitored through digital systems, linking processors, aggregators, toll millers, feed manufacturers, and farmers across the value chain.

Phase 3 (Year 5): Institutionalization and Innovation

The long-term goal is the establishment of industrial-scale HQCP processing facilities capable of handling at least 10 tons of cassava peel per day. Peel processers should be supported to evaluate enzyme treatments (cellulase, beta-glucanase, and xylanase) to improve utilization by decreasing fiber content of cassava peel mash and enable higher-volume inclusion rates in livestock feeds (Chelangat et al., 2025). Research should also focus on biofortification through microbial fermentation and protein enrichment strategies. Early trials in Nigeria have demonstrated conversion rates of up to 60% from waste to feed ingredient on a dry matter basis (ILRI report). The incorporation of protein-rich ingredients such as *Moringa oleifera* leaf meal could further improve nutritional value and enhance HQCP's competitiveness as an alternative feed ingredient (Sugiharto et al., 2020).

5.2 Organic Fertilizer Roadmap for Development and Scale-Up:

Phase 1 (Years 1-2): Foundation Building

Initial efforts should focus on policy advocacy, awareness creation, and establishing the enabling environment for a sustainable organic fertilizer industry. Awareness campaigns should target poultry and crop farmers, emphasizing the safety, productivity benefits, and economic value of properly processed/treated poultry manure-based fertilizers. Demonstration plots and farmer experience and testimonials should be prioritized over technical reports to build trust and encourage adoption, particularly in cocoa, cashew, cotton, and staple crop systems.
A dedicated regulatory framework for organic fertilizers should be developed, recognizing them as a distinct product category rather than treating them as compost or chemical fertilizers. The 50,000 EUR product registration fees should be reviewed, to encourage investment and industry growth, while investments in laboratory and quality-testing infrastructure are needed to strengthen private and national analytical capacity. Pilot production sites should be established close to large poultry operations, such as FOANI farms, to reduce transport costs and ensure reliable manure supply. Standardized quality and safety standards covering nutrient content, contaminants, moisture levels, and labelling should align with EU Regulation 2019/1009 (ECN, 2026) to support future market investment opportunities. Training programs developed with institutions such as CNRA, CGIAR, ILRI, FOANI ITC, and INP-HB should provide farmers and extension agents with practical knowledge and generate the technical evidence required for scaling adoption.

Phase 2 (Years 3-4): Scaling and Validation

Scaling efforts should focus on strengthening financing, monitoring, and evidence generation. Producers should be linked to financing opportunities through institutions such as IFC, local banks, and the Africa Fertilizer Financing Mechanism administered by the African Development Bank (AFDB, 2019). Market linkages to development funded programs should be established. A monitoring and evaluation system, including a Management Information System (MIS), should track adoption and impact across pilot areas.

A comprehensive agronomic assessment led by the Ministry of Agriculture, CGIAR, INP-HB/ESA, and ILRI should evaluate at least two seasons of demonstration plot data, documenting impacts on yields, soil health, and farm profitability. The resulting validated evidence base will be critical for influencing policymakers, investors, and commercial buyers, and for developing crop-specific fertilizer recommendations.

Phase 3 (Year 5): Institutionalization and Growth

Long-term efforts should focus on establishing a national stakeholder platform to develop a National Master Plan and regulatory framework for organic fertilizers, including legislation that elevates soil health and organic amendments alongside chemical fertilizers. A national soil health monitoring program should track long-term changes in soil organic matter, nutrient levels, and water retention on farms using organic fertilizers, generating the evidence needed to refine recommendations and support policy development. Product innovation should also be encouraged through fertilizer enrichment strategies, including the incorporation of mineral nutrients or biochar to develop crop-specific formulations for cocoa, cashew, cotton, and staple crops, increasing product differentiation and market value.

6. Conclusion & Final Recommendations

Organic fertilizer produced from properly composted and treated chicken manure offers a sustainable nutrient source for the cultivation of maize, soybean, cassava, and other crops. Combined with the valorization of high-quality cassava peels (HQCP) as an ingredient in poultry feed, these solutions create a truly circular production system in which by-products from cassava processing are reintegrated into poultry feed production, effectively closing resource loops within the poultry value chain. This aligns with the principles of circular economy and sustainable resource management.

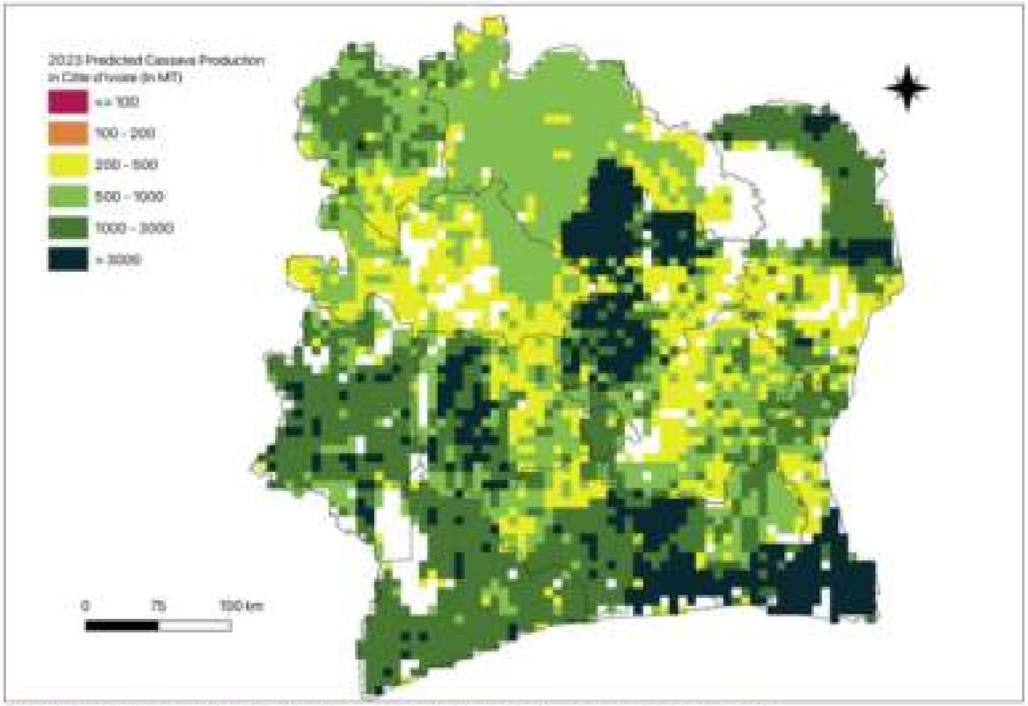
Recent global geopolitical developments have exposed the vulnerability of Côte d'Ivoire's agricultural sector to supply disruptions and price volatility in imported fertilizers and feed ingredients, particularly maize. The solutions presented in this study provide locally sourced alternatives that can help mitigate these risks, reduce dependence on imports, and strengthen the resilience of both the poultry and crop production sectors.

Pilot implementation should initially be conducted on a small scale to assess the economic viability of the proposed products under local conditions. Such pilots should evaluate production processes, machinery requirements and efficiency, operational costs, and market demand for pelletized organic fertilizers and cassava peel-based products. Particular attention should be given to identifying market opportunities for different Cassava product profiles, including applications beyond the poultry sector, as well as exploring regional export opportunities. Additional support may be sought through grant funding and investment mechanisms offered by the African Development Bank, the Dutch government, and other development partners.

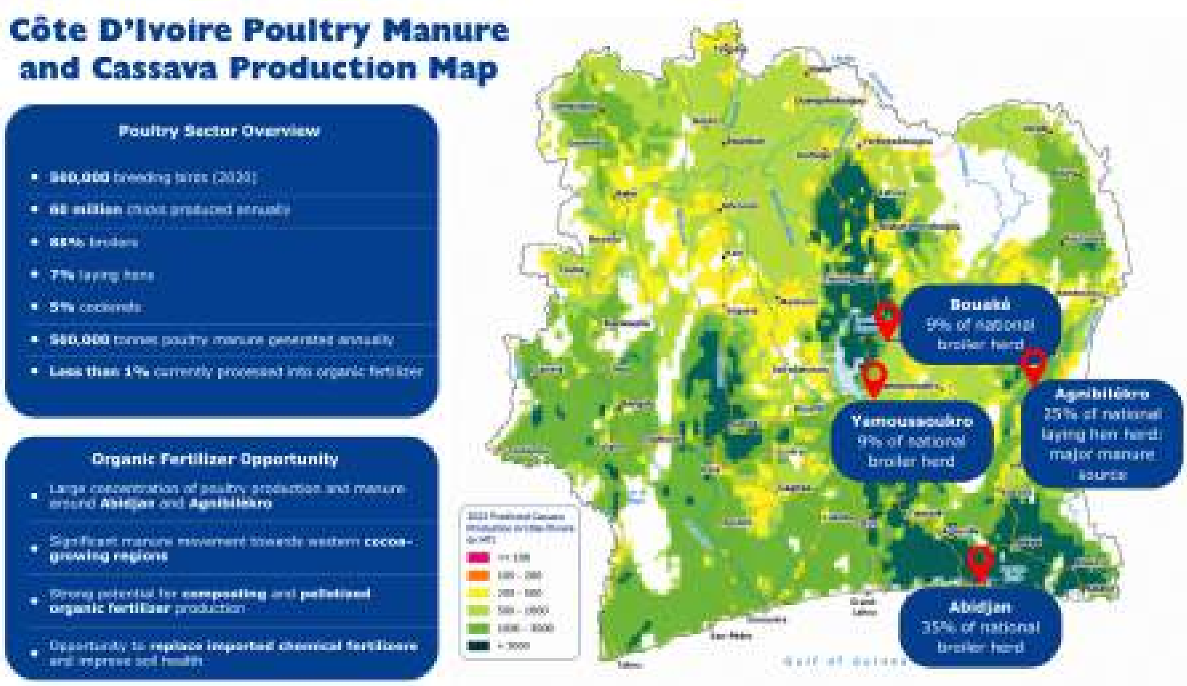
Strategic and sustained engagement with policymakers, regulators, industry stakeholders, and value chain actors will be essential to support the development of appropriate quality standards, regulatory frameworks, commercialization pathways, and market adoption. Several local partners have already expressed interest in advancing both product streams, providing a sturdy foundation for future collaboration.

The proposed solutions and pilot initiatives present an opportunity to strengthen both the poultry and cassava value chains through a more integrated and circular approach to production. Given the importance of cassava as a staple crop and poultry as a key source of animal protein in Côte d'Ivoire, these interventions can contribute to improved food security, environmental sustainability, and climate resilience. Furthermore, they can support efforts to address emerging challenges affecting agricultural productivity, including climate change, cassava mosaic disease, and bacterial blight, while promoting more efficient use of locally available resources.

Annex 1: Cassava Production Map



Data Source: Africa Agriculture Watch (www.aagwa.org).



Annex 2: Financial Analysis HQCP

FINANCIAL ANALYSIS

Processing and Valorization of Dried Cassava Peels (HQCP)

Conversion rate XOF 656 = € 1

- **IN SHORT**

This analysis evaluates the financial viability of producing dried cassava peels as a feed ingredient or processing input for Côte d'Ivoire's poultry value chain, based on real operational data from Koudijs/De Heus' supplier network. The model assesses the full cost structure for producing one metric ton of dried product and tests profitability under multiple operational scenarios.

> Key finding: The model is not viable under current conditions, generating a loss of CFAF 28,295/t (−23.9%, with costs exceeding the market price. Costs are highly concentrated, with feedstock (56.4%) and transport (32.4%) totaling ~89%. High moisture content (~70%) makes long-distance transport inefficient, as most of the cost is tied to moving water rather than usable material.

Free or near-free feedstock is the main driver of profitability, shifting the model to a +74.3% margin and confirming it as the key viability lever. The optimal setup (free feedstock with local processing and no transport) yields very high margins (+576.9%), while even partial cost reductions are sufficient to restore profitability (+36.8%).

The current break-even (CFAF 118,295/t) is well above market price, confirming unviability. With free feedstock, it drops to CFAF 51,628/t, ensuring strong viability.

Viability depends on zero-cost feedstock, localized processing, and reduced logistics costs. Key risks include limited demand and cassava seasonality, both of which must be validated before scaling.

- **ANALYTICAL METHODOLOGY**

The data utilized in this analysis are sourced directly from Koudijs/De Heus' suppliers and are grounded in actual operational records rather than hypothetical assumptions, thereby providing a strong empirical basis for the assessment. The production volume considered is strictly aligned with Koudijs/De Heus's demand requirements and serves as the baseline reference for all volume-related calculations. Estimates of water consumption and labor requirements for washing and drying operations have been derived from established technical benchmarks applied to the available data.

This analysis aims to determine the production cost of one metric ton of dried cassava peels intended for integration into Côte d'Ivoire's poultry value chain, either as a feed ingredient or as a base product for value-added processing. The model comprehensively captures the full cost structure, encompassing the procurement of fresh cassava peels, processing, drying, packaging, and final delivery of the finished product.

- ### Key technical assumptions

Technical Parameter	Value / Assumption
Moisture content of fresh cassava peels	70%; only 30% of the fresh mass represents usable dry matter
Conversion ratio	3.33 tons of fresh peels → 1 ton of dried peels (conversion factor: 1:3.33)
Baseline production volume (Koudijs/De Heus demand)	11.11 tons of cassava roots → 3.33 tons of fresh peels → approximately 1 ton of dried peels
Estimated washing water requirement	3–5 liters per kg of fresh peels → 10–17 m^3 for 3.33 tons
Water tariff (Tier 3 + 18% VAT)	CFAF 403.3/m^3 + 18% VAT → equivalent to CFAF 295.35 per 100 kg of fresh peels
Daily labor rate	CFAF 500 per worker-day
Drying period	5 days (solar or open-air drying under tropical conditions)
Base selling price	CFAF 90,000 per ton of dried cassava peels

Source*: Field data.*

- ### Analytical framework

The analysis adopts a structured three-step approach. First, it reconstructs the complete cost structure associated with the production of one metric ton of dried cassava peels, capturing all operational inputs and cost components across the value chain. Second, it evaluates profitability under a base-case scenario using prevailing cost and price assumptions. Third, it simulates alternative scenarios to assess the model's sensitivity to its two most critical cost drivers: feedstock procurement and transportation.

This multi-scenario approach is particularly important given the intrinsic characteristics of raw material. Fresh cassava peels exhibit a high moisture content of approximately 70%, implying that only a limited share of the transported mass constitutes usable dry matter. As a result, transporting fresh peels over extended distances is inherently inefficient, as a sizable proportion of logistics costs is effectively allocated to water rather than value-generating material. Accordingly, the proximity between feedstock supply points and the processing facility emerges as a key determinant of operational efficiency and overall economic viability. Minimizing transport distances is therefore critical to maintaining cost competitiveness and ensuring the sustainability of the production model.

- **RESULTS**

- ### Cost Structure: Base-Case Scenario

Table 1 below presents the detailed breakdown of production costs associated with the generation of one metric ton of dried cassava peels under current sourcing and logistics conditions.

Cost item	Cost (XOF / ton of dried peels)	Share of total cost (%)
Fresh peel procurement (CFAF 2,000 per 100 kg fresh peels)	66,667	56.4%
Transportation (CFAF 1,150 per 100 kg fresh peels)	38,333	32.4%
Washing water (CFAF 295 per 100 kg, VAT included)	9,845	8.3%
Drying labor (5 days × CFAF 500)	2,500	2,.1%
Washing labor	500	0.4%
Packaging	450	0.4%
Total Production Cost	**118,295**	**100%**
Selling Price	**90,000**	-
Net Result (Loss)	**-28,295**	**-23.9%**

Source: *Field data. Cost calculations are based on 33.33 batches of 100 kg of fresh cassava peels required to produce one metric ton of dried cassava peels, assuming a dry matter recovery rate of 30% (conversion ratio of 3.33:1).*

The cost structure indicates a high concentration of expenses in upstream supply and logistics, with feedstock procurement and transportation jointly accounting for approximately 89% of total production costs. These components therefore represent the primary drivers of overall cost performance and profitability.

Under current market conditions, the production of dried cassava peels results in a net loss of CFAF 28,295 per ton, equivalent to a negative margin of 23.9%. This outcome highlights a structural cost imbalance, whereby the prevailing selling price is insufficient to offset input and logistics expenditures.

To achieve financial viability, the model requires either an upward adjustment in the selling price or a reduction in key cost drivers, most critically feedstock acquisition and transportation costs. Improving supply chain efficiency, particularly through shorter sourcing distances or optimized logistics arrangements, is likely to be central to restoring economic sustainability.

○ Interpretation of the Base-Case Scenario

Under the current sourcing and transportation conditions, the model generates a net loss of CFAF 28,295 per ton of dried cassava peels, corresponding to a negative profit margin of 23.9%. The cost structure is highly concentrated, with two components, fresh peel procurement (56.4%) and transportation (32.4%), jointly accounting for 88.8% of total production costs. These elements therefore constitute the principal levers for improving economic performance and achieving profitability.

This outcome is largely driven by a fundamental physical constraint inherent to the raw material. Fresh cassava peels contain approximately 70% moisture, meaning that a significant share of transported mass consists of water rather than usable dry matter. Consequently, long-distance transport results in disproportionately high logistics costs relative to the value of the recoverable output.

In this context, the geographic proximity between feedstock sources and the processing facility emerges as a critical determinant of economic viability. Co-location is not merely a factor of operational efficiency but a structural requirement for cost competitiveness. Business models reliant on the collection and transportation of fresh cassava peels over extended distances are likely to face persistent cost disadvantages that cannot be fully mitigated through incremental operational improvements alone.

○ Scenario Analysis

Four alternative scenarios were simulated to quantify the potential impact of the main improvement levers on the profitability of the business model.

Scenario	Total Cost (XOF)	Net Result (XOF)	Margin (%)	Viable ?
BASE – Current Conditions	118,295	-28,295	-23.9%	**No**
A – Free Feedstock (0 XOF)	51,628	+38,372	+74.3%	**Yes**
B – Free Feedstock + Local Processing (No Transport Cost)	13,295	+76,705	+576.9 %	**Yes**
C – 50% Reduction in Feedstock Cost + 50% Reduction in Transport Cost	65,795	+24,205	+36.8%	**Yes**
D – Free Feedstock + Selling Price of CFAF 120,000/t	51,628	+68,372	+132.4 %	**Yes**

***Source**: Field data.*

Scenario A – Free Feedstock

This scenario reflects the prevailing supplier reality, whereby cassava peels are generated as a by-product and are often disposed of at no cost or at a negligible price. Under this assumption, total production cost declines to CFAF 51,628 per ton, resulting in a profit margin of +74.3%.

> This scenario represents the most immediately actionable lever within the model, as it aligns with existing supplier practices and requires limited structural adjustments.

Scenario B – Zero Feedstock Cost with Localized Processing

This scenario represents the optimal operational configuration, combining zero feedstock cost with the complete elimination of transportation expenses through the co-location of the processing unit at the Cassava Production Site. Under these conditions, the residual production cost is reduced to CFAF 13,295 per ton, covering only water, labor, and packaging. The resulting profit margin reaches +576.9%, highlighting the significant value of integrated, site-based processing.

> While highly profitable, this scenario requires specific operational conditions, including the deployment of mobile or decentralized drying units in high-density cassava production areas.

Scenario C – Partial Cost Reduction (-50%)

In this scenario, both feedstock procurement and transportation costs are reduced by 50%, reflecting achievable improvements through negotiated supply agreements and shorter sourcing distances.

Under these assumptions, the model becomes profitable, generating a margin of +36.8%. This demonstrates that full cost elimination is not a prerequisite for viability, moderate gains in supply chain efficiency are sufficient to reach positive returns.

Scenario D – Zero Feedstock Cost with Increased Selling Price

If cassava peels are obtained at no cost and the selling price of the dried cassava peels reach XOF 120,000 per ton (a 33% uplift compared to the base price), the profit margin rises to +132.4%. This scenario is particularly relevant in the event that the Koudijs/De Heus market allows for a quality premium or if demand conditions are sufficiently structured to support higher pricing levels.

- ### Break-even Analysis

The table below presents the minimum selling price required to reach the break-even point under each cost configuration. It highlights the price thresholds at which revenues are sufficient to fully offset production costs, thereby generating a zero-profit outcome.

Configuration	Break-even Selling Price (XOF/ton)
Current Conditions (Base Case)	118,295 XOF/t (+31.4% vs current selling price)
Free Feedstock (Scenario A)	51,628 XOF/t (-42.6% vs current selling price)
Free Feedstock + Local Processing (Scenario B)	13,295 XOF/t (-85.2% vs current selling price)

***Source**: Field data.*

The break-even analysis highlights the pronounced sensitivity of the model to feedstock procurement costs and transportation expenses. Under current conditions, the break-even selling price (CFAF 118,295 per ton approximately 31% above the current market price), confirming the structural unviability of the base-case configuration. Such a price level is unlikely to be attainable in the short term, unless supported by secured off-take agreements or premium pricing arrangements.

In contrast, when cassava peels are sourced at zero cost, the break-even threshold declines significantly to CFAF 51,628 per ton, well below the prevailing market price, illustrating that securing cassava peels at zero or near-zero cost materially enhances economic feasibility. Scenario B further lowers the break-even price to a minimal level, reflecting an optimized configuration in which costs are largely limited to processing inputs such as water, labor, and packaging.

> Overall, these results underscore that the economic viability of the model is fundamentally contingent on minimizing upstream procurement costs and eliminating transport-related inefficiencies. In particular, localized processing emerges as a critical strategy for improving cost competitiveness and ensuring the sustainability of operations.

- **Estimation of Water and Labor Requirements**

The available cost sheet includes an estimate of water expenditures based on the official Ivorian tariff structure (domestic Tier 3: CFAF 403.3 per m^3, inclusive of 18% VAT). Using this reference point, the following technical parameters were reconstructed to ensure consistency between physical input requirements and associated costs.

Water consumption for the washing process is estimated at approximately 3 to 5 liters per kilogram of fresh cassava peels. Based on the baseline processing volume of 3.33 tons of fresh peels required to produce one ton of dried product, total water usage is estimated to range between 10 and 17 cubic meters per ton of output.

Parameter	Estimation basse	High Estimate
Washing water volume	10.0 m³ (3 L/kg fresh peels)	16.7 m³ (5 L/kg fresh peels)
Water cost (Tier 3 + 18% VAT)	~4 755 CFA	~7,932 XOF
Washing labor	~3.3 days	~3,3 worker-days
Drying labor	5 days (per source sheet)	5 days
Total labor cost	~4,150 XOF	~4,150 XOF

***Source**: Field data. Water requirements are estimated based on standard industrial benchmarks (3–5 L/kg of fresh material). The model applies the upper-bound assumption (5 L/kg), resulting in a water cost of XOF 9,845 per ton. This conservative approach ensures operating costs are not underestimated and supports a robust assessment of economic viability.*

Labor requirements have been similarly derived from operational assumptions. Washing activities are estimated to require approximately one worker-day per ton of dried output, while the drying process extends over a period of five days under typical solar or open-air conditions. At a daily labor rate of XOF 500, total labor costs remain relatively limited compared to upstream procurement and transportation expenses.

> Overall, while water and labor inputs are necessary components of the processing chain, their contribution to total production cost is marginal relative to feedstock acquisition and logistics. These findings further reinforce the conclusion that improvements in supply chain efficiency, rather than process-level optimization, represent the primary pathway to enhancing economic performance.

- ## Conclusions and Strategic Recommendations for NFP/EKN

Conclusions

The analysis confirms that the cassava peel valorization business model is viable under specific conditions but remains structurally unprofitable under the current base-case scenario. The key findings are summarized below:

- Under prevailing conditions, the model generates a loss of CFAF 28,295 per ton, corresponding to a negative margin of 23.9%, primarily driven by feedstock procurement (56.4%) and transportation costs (32.4%).

- The high moisture content of fresh cassava peels (approximately 70%) constitutes the principal physical constraint. Transporting fresh biomass effectively entails transporting water, rendering long-distance logistics inherently inefficient.
- Securing cassava peels at zero or near-zero cost represents the most impactful value lever, shifting the model from a negative margin of 23.9% to a positive margin of 74.3%, without requiring additional operational adjustments.
- Proximity between the processing unit and feedstock sources is a structural prerequisite for economic viability, rather than a simple logistical optimization.
- Labor and water costs remain relatively marginal (10.8% combined) and do not constitute significant barriers to profitability.

Strategic Recommendations

Based on the analysis, the following recommendations are proposed to support the implementation of a viable pilot project:

- Establish formal arrangements with cassava processing units (e.g., Attieke, Garri, and flour producers) to obtain cassava peels at no cost. As these residues are typically treated as waste, such agreements are both feasible and essential to achieving economic viability.
- Locate the drying unit within close proximity (preferably within a 5-7km radius) of high-density cassava processing clusters to eliminate or significantly reduce transportation costs, which are a major cost driver.
- Consider the use of mobile or semi-permanent drying units that can be relocated in line with cassava harvesting cycles. This approach enables continuous access to fresh feed stock while minimizing logistics constraints.
- Systematically assess and document cassava peel availability in terms of volumes, seasonality, and geographic distribution.
- Assess the demand for both dried cassava peels and cassava mash, while incorporating the requirements of De Heus, FOANI, and other potential buyers to identify the most viable and scalable market opportunity.
- The ILRI recommendation of processing the mash must be compared to peel processing in a pilot to establish efficiency and viability in the local context. Koudijs/De Heus only uses peels based on their infrastructure. The market potential and demand could be for mash which based on ILRI research is the most recommended and viable.
- Implement a small-scale pilot based on localized processing with zero-cost feedstock prior to any large-scale capital investment. This will allow for empirical validation of cost assumptions, operational performance, and drying yield parameters under real conditions.
- Pilot the production of HQCP mash in comparison to dried cassava peels to analyze economic viability and efficiency, since the mechanical pressing of the grated peels reduces moisture content from 70% to 32-48% (and cyanide levels to 35ppm well below the safe thresh hold for livestock -90ppm and aflatoxin level 18-20 pp); thereby reducing drying days from 5 to 2-3 days. Storage is also improved due to the less bulky final product in comparison to dried peels.

Annex 3: Financial Analysis Organic Fertilizer

FINANCIAL ANALYSIS

Organic fertilizer

Conversion rate XOF 655 = € 1

- **IN SHORT**

This analysis evaluates the financial viability of poultry manure composting into organic fertilizer in Côte d'Ivoire, comparing two models: a cooperative model (100 tons/month, CAPEX: XOF 76.6 million) and a semi-industrial model with a SHONG 3 t/h pelletizing line (500 tons/month, CAPEX: XOF 356.2 million). It incorporates detailed CAPEX from supplier quotations, a comprehensive OPEX structure, a mixed revenue model (bulk and bagged sales), and five-year profit and loss projections.

> Key finding: the semi-industrial model outperforms the cooperative model across all key financial indicators. It achieves an IRR of 74.3%, an NPV of XOF 1.54 billion at an 8% discount rate, and a 3.5-year payback period under full commercialization, making it a highly attractive investment. By contrast, the cooperative model has an 11-year payback period and generates negative net profit in Year 1, limiting its bankability without grant support.

However, this strong performance relies on full commercialization from Year 1. Sensitivity analysis (60%, 75%, and 100% scenarios) shows that even at 60%, the semi-industrial model remains near EBITDA break-even, while the cooperative model operates at a deficit. The key issue, therefore, is not the financial viability of organic fertilizer production itself, but rather the ability to secure sufficient market demand to justify the investment.

In the case of , the semi-industrial production model of 3t/h, FOANI has access to approximately 100,000 tons of raw material annually, a volume that far exceeds the processing capacities considered under both the cooperative and semi-industrial business models. Consequently, a separate analysis should be carried out to assess the implications of this resource availability and explore larger-scale development scenarios that go beyond the scope of the current business models.

Given the secure feedstock supply, we recommend implementing the pilot phase at FOANI. In addition to reducing supply risk, FOANI's proximity to the Ghanaian border provides access to both the Ivorian and Ghanaian markets, the latter being significantly larger. For comparison, the combined annual production of major compost producers in Côte d'Ivoire (Elephant Vert, LONO, and BioAni) is estimated at approximately 12,000 tons, underscoring the scale of FOANI's growth potential. At the same time, annual organic fertilizer consumption was approximately 32,000 tons, of which 20,000 tons were imported.

- **Summary of key results**

Table 1: Summary of key financial indicators

Indicator	Coop. Pessimistic.	Coop. Realistic	Coop. Optimistic.	Semi Pessimistic.	Semi Realistic	Semi Optimistic.
CAPEX (XOF Million)	76,6	76,6	76,6	356,2	356,2	356,2
Year 1 Revenue (XOF M)	33.3	41.6	55.4	206.6	258.3	344.4
Year 1 EBITDA (XOF M)	-11.6	-3.3	10.6	0.5	52.1	138.2
Year 1 Net Profit (XOF M)	-26.7	-18.4	-4.5	-68.3	-16.6	52.1
NPV @8% (XOF M)	-8.3	39.2	68.0	953.9	1350.4	1542.0
Cumulative 5-Year ROI	56%	136%	180%	441%	588%	652%
Payback period	4.6 years	3.9 years	3.3 years	3.0 years	2.4 years	2.1 years

Source: *Field Data*

> **Verdict**: The semi-industrial model constitutes a viable and attractive investment, provided that a commercialization rate of at least 75% is achieved from the first year of operations. By contrast, the cooperative model would require direct financial support, such as a capital expenditure subsidy or a loan guarantee, to be considered financially feasible.

- **ANALYTICAL METHODOLOGY**

The analysis is based on a fully populated version of the Organic fertilizer Business Model, incorporating detailed CAPEX estimates supported by SHONG supplier quotations, a comprehensive OPEX structure, and a revenue model combining bulk and bagged organic fertilizer sales. This assessment is grounded entirely in real, documented cost data and financial information collected during field data collection and incorporated into the financial model.

  - **Analytical framework**

The analysis is structured around various key dimensions. The structural analysis examines the composition of CAPEX, including the share attributable to the SHONG pelletizing line, as well as the OPEX structure, identifying major cost drivers and potential efficiency gains. The break-even analysis determines the minimum price and production levels required to achieve profitability.

A cross-sensitivity analysis (price × commercialization rate) maps profitability and loss thresholds under varying market conditions. Scenario analysis projects three commercialization pathways over a five-year horizon. Competitive analysis positions the product within the Ivorian soil amendment market. Finally, a decision-oriented assessment formulates actionable recommendations for NFP/EKN.

○ Assumptions and parameters

The analysis applies a discount rate of 8%, corresponding to the model's weighted average cost of capital (WACC). Corporate income tax (BIC) is set at 25%, in line with Côte d'Ivoire's tax framework. Operational inflation is assumed at 5% annually. Revenue growth rates are projected at 30% per year for the cooperative model and 50% for the semi-industrial model, consistent with the business model assumptions.

Depreciation is applied by asset category, with equipment depreciated over seven years and infrastructure over 15 to 20 years. Debt financing covers 40% of CAPEX for the cooperative model at an interest rate of 12%, and 50% for the semi-industrial model at an interest rate of 11%.

Three commercialization scenarios are considered:

- **Pessimistic**: 60% commercialization in Year 1, increasing gradually to 85%;
- **Realistic**: commercialization ranging from 75% to 100%;
- **Optimistic**: full commercialization (100%) from Year 1, in line with the business model assumptions.

• RESULTS

○ Investment Architecture

The investment architecture highlights fundamentally different profiles across the two models. The cooperative model, with a CAPEX of XOF 76.6 million (approximately EUR 116,800), is primarily driven by infrastructure, which accounts for 42% of total investment, followed by the SHONG pelletizing line at 21%. This represents a relatively accessible investment for a well-structured agricultural cooperative and could be financed through existing mechanisms such as FDFP, BNI, or cooperative development funds.

In contrast, the semi-industrial model requires a significantly larger investment of XOF 356.2 million (approximately EUR 543,000) and incorporates a substantial logistics component. Logistics assets amount to XOF 94.5 million, including a pay-loader (XOF 24.5 million) and at least two 20-ton trucks (XOF 35 million each), representing 27% of total CAPEX. Infrastructure remains the largest cost category, accounting for 42% of the total (including a concrete platform at XOF 90 million and a warehouse at XOF 30 million).

This investment requires a structured financing approach combining bank debt, equity, and potentially in-kind contributions from a land-owning partner. Importantly, the use of verified supplier quotations, particularly for the SHONG line (CIF Abidjan) and infrastructure costs based on local market prices, significantly reinforces the reliability of these CAPEX estimates.

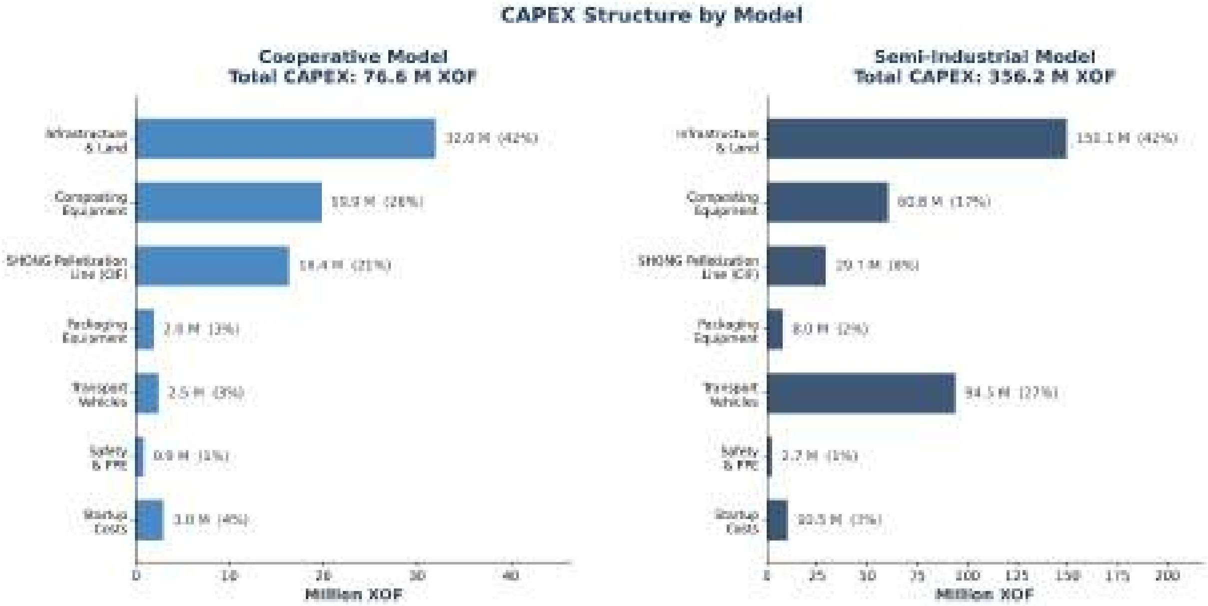


***Figure 1**. CAPEX structure by cost item and by model*

- ### Operating Cost Structure

The cooperative model has a monthly OPEX of XOF 3.74 million (XOF 44.9 million annually), primarily driven by labor costs (40.1%) and raw materials (32.1%). This cost structure reflects the labor-intensive nature of typical West African cooperative operations, where mechanization remains limited. The unit cost of production is estimated at XOF 106,835 per ton of finished organic fertilizer, yielding a theoretical margin of approximately 23% against an average weighted selling price of XOF 132,000 per ton.

The semi-industrial model records a monthly OPEX of XOF 17.2 million (XOF 206.2 million annually), with costs largely driven by raw materials (41.9%), followed by labor (24.4%). Clear economies of scale are observed, with the unit production cost reduced to XOF 98,183 per ton, around 8% lower than the cooperative model. Combined with a higher average selling price (XOF 164,000 per ton, supported by a 60% share of bagged sales), this results in a unit gross margin equivalent to 67% of the cost price, representing strong sector performance.

A key risk factor is related to energy costs, estimated at XOF 1.3 million per month for the semi-industrial model. This reflects the high electricity consumption of the pelletizing line, comprising motors, crushers, and granulators with a combined installed capacity exceeding 100 kW. Given the frequency of power disruptions in Ivorian industrial zones, such dependency could directly constrain production. The inclusion of a backup generator, currently not accounted for in CAPEX, should therefore be considered as a risk mitigation measure.

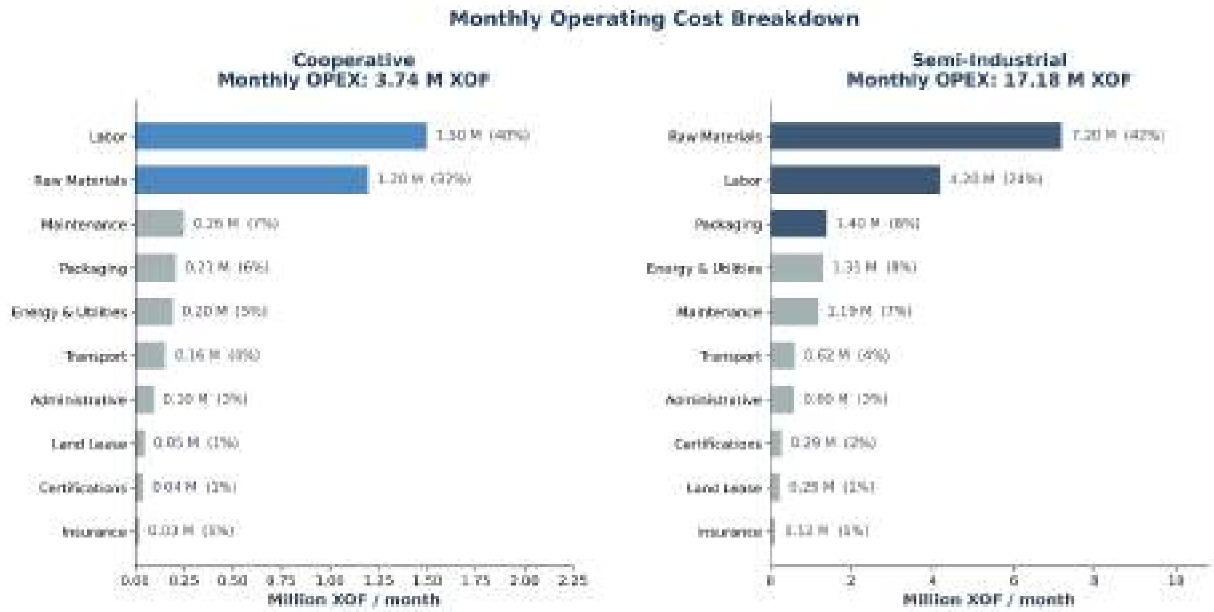


***Figure 2**. Breakdown of monthly operating costs*

- ### Revenue Structure and Market Positioning

The revenue model incorporates a differentiated mix between bulk and bagged sales across the two business models. The cooperative model prioritizes bulk sales (60%) at XOF 120,000 per ton, targeting large-scale farms and plantations, complemented by 40% bagged products (50 kg bags priced at XOF 7,500, equivalent to XOF 150,000 per ton). This results in a weighted average selling price of XOF 132,000 per ton.

By contrast, the semi-industrial model adopts a higher-value strategy, with 60% of output sold in bagged form (50 kg bags at XOF 9,000, equivalent to XOF 180,000 per ton) and 40% in bulk at XOF 140,000 per ton, yielding an average price of XOF 164,000 per ton. This positioning is supported by the SHONG pelletizing process, which produces a homogeneous, pelletized organic fertilizer comparable to chemical fertilizers in terms of handling and application.

This approach enables an "affordable premium" positioning within the Ivorian market, bridging the gap between low-cost artisanal compost (from approximately XOF 80,000 per ton) and chemical fertilizers such as 15-15-15 (around XOF 600,000 per ton). The resulting value-for-money proposition is particularly compelling for cocoa, rubber, and oil palm producers, which constitute the primary target market.

At full commercialization, the semi-industrial model generates monthly revenue of XOF 28.7 million, approximately 6.2 times higher than the cooperative model (XOF 4.6 million), while its OPEX is only 4.6 times greater. This differential creates a strong operational leverage effect, underpinning the superior financial performance of the semi-industrial model.

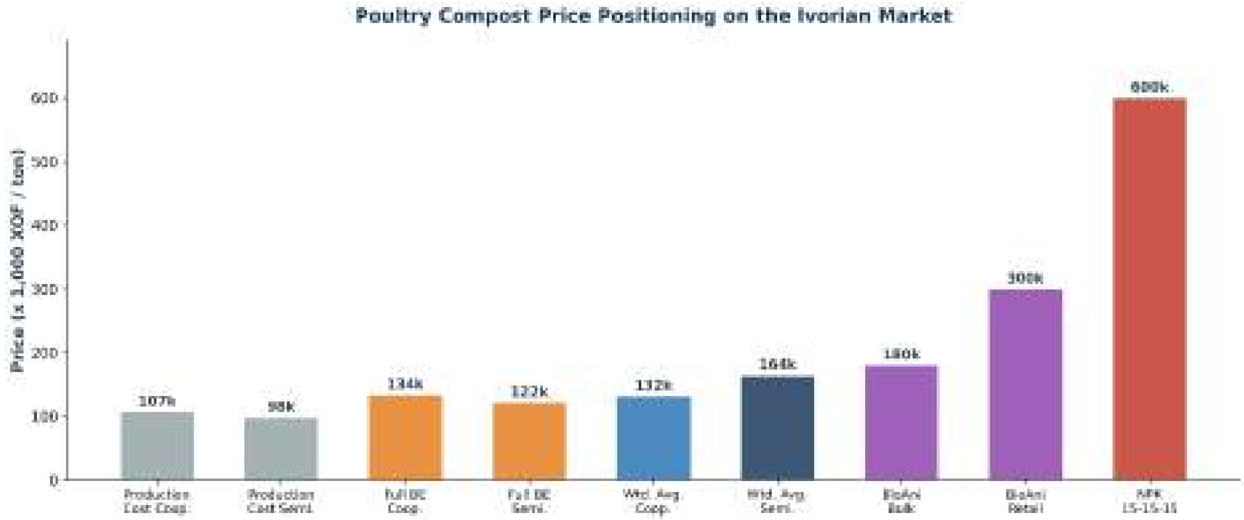


***Figure 3**. Pricing positioning of poultry compost/organic fertilizer in the Ivorian market.*

- **Break-Even Analysis**

The break-even analysis highlights a fundamental structural divergence between the two models.

The cooperative model exhibits an OPEX break-even point of XOF 106,835 per ton and a full break-even threshold (including depreciation) of XOF 133,979 per ton. With a weighted average selling price of XOF 132,000 per ton, the model operates slightly below its full cost recovery level. Consequently, even at full commercialization, it does not fully cover depreciation expenses. This results in a net loss in Year 1 (−XOF 4.5 million), with profitability achieved only from Year 2 onward, supported by an assumed annual revenue growth of 30%.

In contrast, the semi-industrial model demonstrates a far more robust profile. Its full break-even point of XOF 121,581 per ton remains well below its average selling price of XOF 164,000 per ton, providing a 35% margin of safety. Even under a 20% price reduction scenario, the model would continue to operate above its OPEX break-even level. This resilience to price fluctuations represents a key strength from an investment perspective.

> From a volume standpoint, the cooperative model reaches break-even at 28.3 tons per month, corresponding to 81% of its 35 tons/month capacity. The semi-industrial model, by comparison, breaks even at 104.8 tons per month, or 60% of its 175 tons/month capacity. This translates into a significantly larger operational buffer—40% of capacity for the semi-industrial model versus only 19% for the cooperative—further reinforcing its superior risk profile.

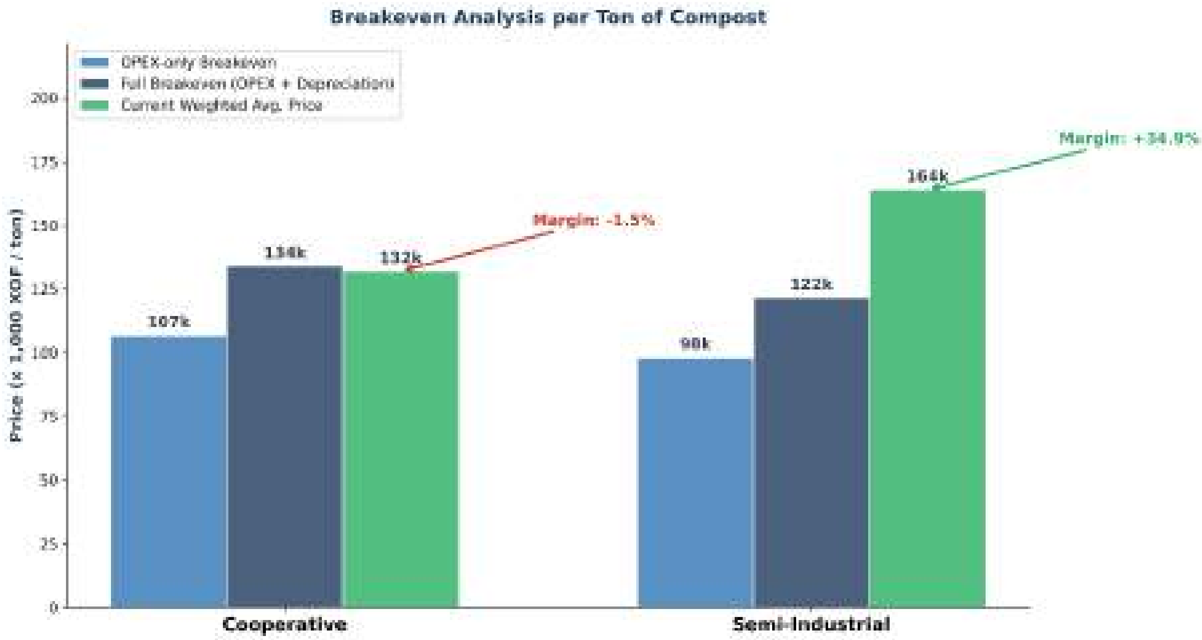


Figure 4. *Break-even thresholds (OPEX only vs. OPEX + depreciation) by model*

- **Sensitivity Analysis**

The cross-sensitivity analysis (price × commercialization rate) constitutes the most powerful decision-making tool in this report. The heatmap below presents Year 1 EBITDA (in XOF millions) for each combination of price variation (−30% to +30%) and commercialization rate (50% to 100%).

Cooperative model: The operational viability zone (positive EBITDA) is narrow. At current prices, a commercialization rate of at least 85% is required to achieve positive EBITDA. Alternatively, if commercialization is limited to 75%, a minimum price increase of 10% is necessary. This limited margin of safety makes the cooperative model inherently vulnerable to market fluctuations.

Semi-industrial model: By contrast, the semi-industrial model generates positive EBITDA across nearly the entire matrix. Even under the most adverse scenario tested (−30% price and 50% commercialization), the resulting deficit remains relatively contained. At a 75% commercialization rate and unchanged prices, EBITDA exceeds XOF 50 million.

> This strong resilience to simultaneous price and volume shocks represents the key advantage of the semi-industrial model: it can absorb significant deviations from the business plan without jeopardizing operational sustainability.

Figure 5. *Cross-sensitivity analysis: price × commercialization rate → Year 1 EBITDA*

5-Year Projections by Scenario

Table 2. Assumptions across three commercialization scenarios

Parameter	Pessimistic	Realistic	Optimistic (Business Model)
Year 1 commercialization	60%	75%	100%
Year 2 commercialization	70%	85%	100%
Year 3+ commercialization	75-85%	90-100%	100%
Revenue growth (cooperative)	+30%/year	+30%/year	+30%/year
Revenue growth (semi-industrial)	+50%/year	+50%/year	+50%/year

Source: *Field Data*

Five-year cumulative cash flow projections reveal markedly different trajectories between the two models.

The semi-industrial model achieves payback within 2.1 years under the optimistic scenario, 2.4 years under the realistic scenario, and 3.0 years under the pessimistic scenario, consistently recovering the initial investment before the end of Year 3. Over five years, cumulative cash flow reaches XOF 2.2 billion in the optimistic case, XOF 1.4 billion in the realistic case, and XOF 954 million in the pessimistic scenario. These results indicate exceptionally strong performance for an agro-industrial investment in West Africa.

The cooperative model follows a more gradual trajectory. Payback is achieved in 3.3 years under the optimistic scenario, with a cumulative five-year cash flow of XOF 68 million. Under the realistic and pessimistic scenarios, payback extends to 3.9 years and 4.6 years, respectively. While comparatively modest, these outcomes remain acceptable for a cooperative structure, provided that financing is secured on concessional terms or supplemented by partial CAPEX subsidies.

> A key insight is that revenue growth assumptions—30% annually for the cooperative model and 50% for the semi-industrial model—are the primary drivers of long-term profitability. Achieving such growth, while plausible given the structural deficit in organic soil amendments and increasing sustainability pressures in cocoa and rubber value chains, would require revenue to double approximately every 2 to 2.5 years. This, in turn, implies a highly proactive commercial strategy and sustained investment in marketing and distribution, which may not be fully reflected in the current OPEX assumptions.

Figure 6. Cash-flow 5year cumulative scenario

- ### Detailed Income Statement (Optimistic Scenario – Business Model Assumptions)

The income statement under the optimistic scenario, aligned with full (100%) commercialization, illustrates the projected profitability trajectory of both models.

The semi-industrial model generates an EBITDA of XOF 138.2 million in Year 1, corresponding to a margin of 40%. Profitability improves significantly over time, with the EBITDA margin reaching 86% in Year 5 (XOF 1.49 billion EBITDA on XOF 1.74 billion in revenue). Net income increases from XOF 52 million in Year 1 to XOF 1.08 billion in Year 5, reflecting strong operating leverage and scaling effects.

The cooperative model follows a similar trajectory but at a much smaller scale. Its Year 1 EBITDA of XOF 10.6 million (19% margin) highlights the structural limitation imposed by low production capacity (35 tons per month), which constrains the absorption of fixed costs. Net income turns positive only in Year 2 (X

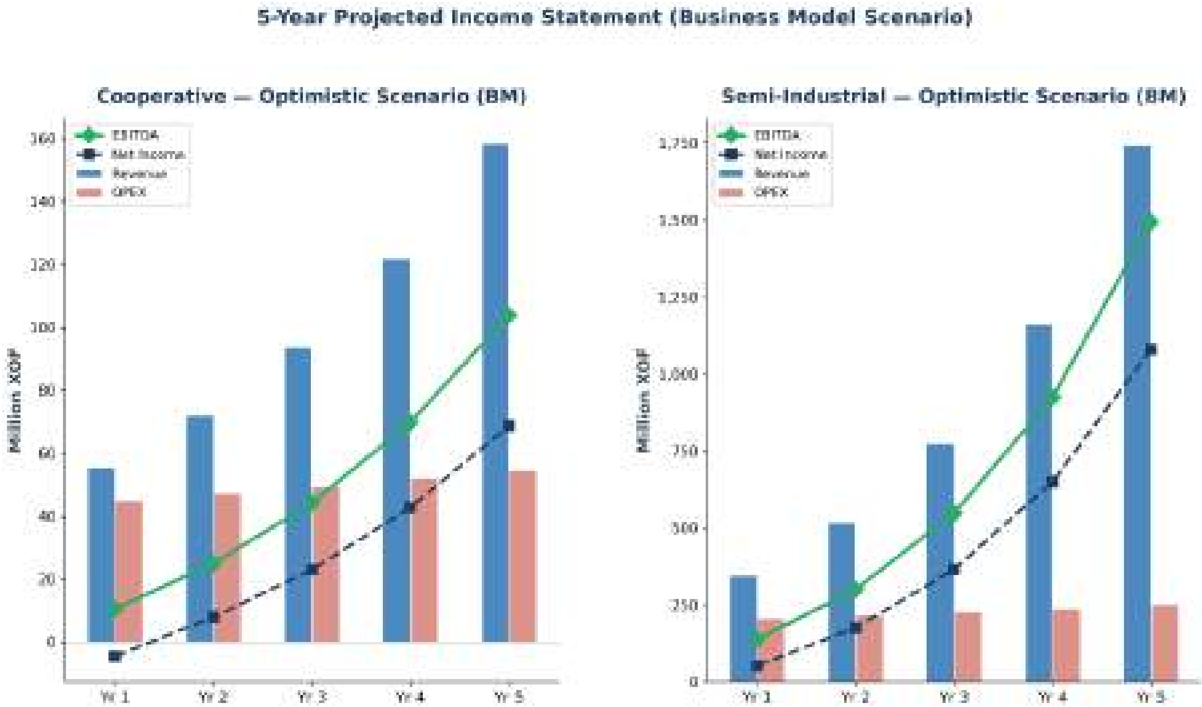


***Figure 7**. Five-year projected income statement (business model, optimistic scenario)*

- ### Dashboard Summary

The table below consolidates all key financial indicators across the six model × scenario combinations, providing an immediate overview to support decision-making.

Table 3: Financial KPI summary dashboard

Indicator	Coop. Pessimistic.	Coop. Realistic	Coop. Optimistic.	Semi-indus Pessimistic.	Semi-indus Realistic	Semi-indus Optimistic.
CAPEX (XOF Million)	76,6	76,6	76,6	356,2	356,2	356,2
Year 1 Revenue (XOF M)	33.3	41.6	55.4	206.6	258.3	344.4
Year 1 EBITDA (XOF M)	-11.6	-3.3	10.6	0.5	52.1	138.2
Year 1 Net Profit (XOF M)	-26.7	-18.4	-4.5	-68.3	-16.6	52.1
NPV @8% (XOF M)	-8.3	39.2	68.0	953.9	1350.4	1542.0
Cumulative 5-Year ROI	56%	136%	180%	441%	588%	652%
Payback period (years)	4.6 yr	3.9 yr	3.3 yr	3.0 yr	2.4 yr	2.1 yr

***Source**: Field Data*

The results clearly favor the semi-industrial model despite its higher CAPEX (XOF 356.2 million vs. XOF 76.6 million). Across all scenarios, it generates significantly higher revenues, stronger profitability, and substantially greater value creation.

While the cooperative model records negative Year 1 net profits under all scenarios and achieves only modest returns (5-year ROI of 56–180%), the semi-industrial model delivers robust performance, with a 5-year ROI ranging from 441% to 652%, NPV between XOF 954 million and XOF 1.54 billion, and payback periods of 2.1–3.0 years.

> Overall, the semi-industrial model emerges as the financially superior investment option, while the cooperative model may be best positioned as a pilot phase to test market demand and operational assumptions before scaling up.

- ## Strategic Analysis and Positioning

The project benefits from three key structural competitive advantages.

  - The integration of a SHONG pelletizing line, already costed and readily available, enables the production of high-quality pelletized organic fertilizer, which is directly comparable to chemical fertilizers in terms of handling and application. This capability constitutes a significant differentiating factor in the market.

  - Institutional support from NFP/EKN enhances the project's credibility with large institutional buyers, such as plantations and cocoa cooperatives, while also facilitating access to financing.

The Ivorian market for organic soil amendments is expanding rapidly, driven by two converging dynamics. On one hand, sustainability requirements in export value chains, such as UTZ/Rainforest Alliance certification for cocoa and RSPO standards for palm oil, are structurally increasing demand for organic inputs. On the other hand, the sustained rise in chemical fertilizer prices, exacerbated by geopolitical disruptions in global fertilizer markets since 2022, is improving the relative competitiveness of organic alternatives.

The project's pricing range (XOF 132,000 to 164,000 per ton) remains four to five times lower than that of chemical fertilizers such as 15-15-15, providing a strong value proposition despite differences in nutrient concentration.

Although financially less attractive, the cooperative model retains strategic relevance. Its relatively low CAPEX requirement (XOF 76.6 million) enables a low-risk market entry. Insights gained from commercialization performance, customer preferences (bulk versus bagged), logistics, and actual operating costs would be critical in refining the semi-industrial investment. This phased approach, progressing from a cooperative pilot to semi-industrial scale, is aligned with best practices in risk mitigation for agro-industrial development projects.

- ## RECOMMENDATIONS FOR NFP/EKN

The analysis strongly supports the semi-industrial model as the primary investment priority. With an IRR of 74.3%, significantly above the 11% cost of capital, a payback period of 3.5 years, and a cumulative return on investment (ROI) of 652% over five years (optimistic scenario), the project demonstrates substantial value creation potential. Even under the realistic scenario (75% commercialization in Year 1), the payback period remains limited to 2.4 years, with ROI exceeding 400%, positioning semi-industrial organic fertilizer production among the most attractive opportunities in poultry waste valorization.

Project viability depends on four interdependent factors:

- Market security is critical: achieving at least 75% commercialization in Year 1 requires pre-secured offtake agreements with cocoa cooperatives, industrial plantations, or agricultural input distributors. These commercial arrangements should be in place prior to construction.
- The financial structure should combine debt financing (approximately 50% at 11%, through institutions such as BNI or BOAD) with equity and/or grant funding.
- Reliable energy infrastructure is essential to support the pelletizing line, given its installed capacity exceeding 100 kW.
- The supply chain must ensure consistent access to approximately 500 tons of raw material per month, secured through contractual arrangements with medium-scale poultry producers.

The principal risk is commercial, specifically, the capacity to sell 175 tons of pelletized organic fertilizer per month from Year 1. Mitigation should focus on a robust pre-commercialization strategy, including demonstration plots, partnerships with agricultural extension services, and accreditation by the Ministry of Agriculture and Rural Development (MINADER). Supply risk, linked to potential variability in poultry manure availability, can be reduced through diversified sourcing and buffer storage. Technical risks, such as equipment downtime or raw material quality issues, require targeted staff training and a maintenance agreement with the SHONG equipment supplier. Regulatory risk, including certification requirements and evolving standards, is already incorporated into OPEX (XOF 3.5 million annually for the semi-industrial model).

Three priority actions are recommended for NFP/EKN. First, conduct a quantitative market assessment targeting cooperatives, plantations, and distributors to validate demand volumes and preferred distribution channels. Second, initiate discussions with financial institutions (BNI, BOAD, FDFP) to structure an appropriate financing package based on the findings of this analysis. Third, finalize site selection and obtain detailed quotations from local contractors for key infrastructure components—including the concrete platform, storage warehouse, and electrical connection—to further refine CAPEX estimates.

Annex 4: Financial Analysis Black Soldier Fly

FINANCIAL ANALYSIS

Black Soldier Fly (BSF) and Improved Frass

Conversion rate XOF 656 = € 1

- **IN SHORT**

This report presents the economic viability analysis of Black Soldier Fly Larvae (BSFL) and frass production in Côte d'Ivoire, conducted under the NFP/EKN circular poultry economy project. This report presents a rigorous financial analysis of Black Soldier Fly (BSF) larvae production in Côte d'Ivoire (CIV), conducted as part of the NFP/EKN poultry circular economy project. Input data was provided by the largest BSFL producer in Côte d'Ivoire (field interview, May 2026). Two business models are analyzed: a cooperative model (10 tons of substrate per month) and a semi-industrial model (80 tons per month), over a five-year planning horizon (2026–2031). The financial analysis reveals that, under current market conditions documented, both models operate at a loss throughout the analysis period.

> Key finding: Frass(improved with poultry manure) constitutes the dominant revenue stream in both models, accounting for approximately 68% of total revenues, compared to 32% generated by dried larvae. This indicates that frass is the primary economic driver of these production systems. As a result, it should therefore be treated as the primary economic driver in investment and strategic decisions.

Both models are currently operating at a deficit, with expenses exceeding revenues. This reflects the early-stage development of the BSF sector in Côte d'Ivoire and should not be seen as a reason to stop operations. Instead, it provides a baseline to identify and prioritize improvements in efficiency, cost optimization, and revenue generation across the value chain.

- **Summary of key results**

Table 1: Summary of key financial indicators

Key indicator	Coopérative model	Semi-Industrial model
Substrate volume processed	10 t/month	80 t/month
Total investment (CAPEX + working capital)	3,7 M XOF (~5 600 EUR)	155,5 M XOF (~237 000 EUR)
Annual revenue (Year 1)	5,8 M XOF	63,2 M XOF
of which frass (fertilizer)	3,96 M XOF — 67,9 %	43,2 M XOF — 68,4 %
of which dried larvae (protein)	1,88 M XOF — 32,1 %	20,0 M XOF — 31,6 %
Total annual OPEX	9,3 M XOF	74,6 M XOF
Annual EBITDA	-3,5 M XOF (-59 %)	-11,4 M XOF (-18 %)
Annual net result	-4,8 M XOF	-62,5 M XOF*
Frass price required to cover OPEX	281 XOF/kg (+87 %)	189 XOF/kg (+26 %)

Source: BM_BSFL_CIV_EN.xlsx (29/05/2026) & BioAni (2026). ** The net result for the semi-industrial model is strongly affected by an exceptional depreciation charge of 51.1 million XOF in the first year*.

> The semi-industrial model shows the strongest potential. A modest increase in frass price—from 150 to 189 XOF/kg (+26%)—is enough to cover operating costs. This target is achievable if frass quality is certified and clearly positioned against chemical fertilizers.

The recommendations target decision-makers at NFP and EKN Abidjan and focus on three priorities:
(1)position improved frass as the main commercial product by improving quality and packaging;
(2) secure low-cost substrate supply through formal agreements; and
(3) prioritize the semi-industrial model for piloting, given its stronger EBITDA and short-term profitability potential.

- **ANALYTICAL METHODOLOGY**

The input for this analysis is based on field data collected during an interview conducted in May 2026. BioAni is recognized as the leading industrial BSFL production unit in Côte d'Ivoire. The data covered production parameters, investment costs (CAPEX), operating costs (OPEX), sales prices, and financial assumptions. The financial model covers four main components:

CAPEX (Capital Expenditure): Initial investments in infrastructure, production equipment, packaging, biosafety, logistics, training, and start-up costs. Source: quotations from Chinese market prices for industrial equipment (Suntech company).

Working Capital Requirement (WCR): Initial working capital equivalent to N months of OPEX before first revenues (cooperative: 2 months; semi-industrial: 3 months). Integrated into total investment.

Monthly OPEX: Operating expenses broken down into categories: substrates, labor, packaging, transport, energy, and maintenance.

5-Year Profit & Loss Projection: projections of revenue, EBITDA, and net profit.

In addition, three complementary analytical blocks structure the results.

Analytical Blocks.

Block A — Break-even Analysis: Determination of the minimum sales price of the frass and production volume required to cover operating expenses

Block B — Sensitivity Analysis: Variation in frass selling price (from 100 to 300 XOF/kg) and its impact on the monthly EBITDA of both models.

Block C — Scenario Analysis (3 Scenarios): Three scenarios (pessimistic, realistic, and optimistic) were evaluated for each model over the full 5-year horizon.

Financial assumptions:

The key parameters used in the financial model are as follows: a discount rate (WACC) of 18%, consistent with World Bank (2023) benchmarks for West Africa; a corporate income tax (BIC) rate of 25%, in line with DGDI regulations (2024, Côte d'Ivoire); and constant operating assumptions over a five-year period, without gradual scale-up, in accordance with the methodology applied in the source workbook.

Limitations:
Several limitations should be taken into account when interpreting the results. The P&L projections are based on constant assumptions throughout the five-year period. In practice, a progressive commercial scale-up would likely enhance financial performance over time.

In addition, certain cost components—such as biosecurity, insurance, and administrative expenses—are currently set to zero in the model, leading to a slight underestimation of actual operating costs.

Finally, it is strongly recommended to validate substrate supply costs at the field level prior to making any financial commitment, as variations in these inputs could materially affect overall profitability.

RESULTS

The table below presents the corrected operational parameters after integrating observations.

Tableau 2: Operational parameters.

Parameter	Unit	Cooperative	Semi-industrial
Substrate processed/month	t/month	10	80
FCR (kg substrate/kg fresh larvae)	kg/kg	8	6
Fresh larvae production/month	kg/month	1,250	13,333
Fresh-to-dry ratio (larvae moisture content)	Kg : kg	4 : 1	4 : 1
Dried larvae production/month	kg/month	313	3,333
Frass yield (kg frass / kg substrate)	kg/kg	0,22	0.30
Frass production/month	kg/month	2,200	24,000
Commercialization rate (Year 1)	%	100%	100%
Permanent workers	pers.	3	10
Average monthly salary — permanent staff	XOF/pers.	75,000	82,500
Water consumption	m³/mois	0*	0*

***Source**: Field data. * Water = 0 m³/month: the fruits and vegetables used as substrate provide the necessary moisture content (70%), making external water input unnecessary (BioAni, 2026).*

Note: The financial modeling workbook distinguishes between two cost components: (i) the main substrate (e.g., market waste, cereal bran) and (ii) nutritional additives (e.g., lime, flour). These are separate inputs and are accounted for independently. Substrate supply costs are estimated at 15,000 XOF per ton for the cooperative model and 12,000 XOF per ton for the semi-industrial model, assuming commercial agreements with organic waste suppliers. These costs cannot be considered negligible or set to zero, as this would not reflect realistic field conditions and could lead to a significant underestimation of operating expenses

- ### Operating Expense (OPEX) Structure

The breakdown of monthly operating expenses highlights markedly different cost structures between the two models, reflecting differences in scale, operational intensity, and technological requirements.

Tableau 3: Monthly OPEX structure

Cost Item	Cooperative (XOF/month)	% OPEX	Semi-Industrial (XOF/month)	% OPEX
Substrates and raw materials	280 000	36,1 %	1 740 000	28,0 %
Labor	225 000	29,0 %	825 000	13,3 %
Packaging / conditioning	39 550	5,1 %	382 667	6,2 %
Substrate collection transport	150 000	19,4 %	0	0,0 % *
Energy (dryer, ventilation)	44 550	5,7 %	2 696 100	43,4 %
Land costs	0	0,0 %	0	0,0 %
Biosecurity	0	0,0 %	0	0,0 % **
Maintenance & overheads	35 933	4,6 %	570 137	9,2 %
Total monthly OPEX	775 033	100 %	6 213 904	100 %
Total annual OPEX	9 300 396		74 566 842	

Source: *Field data. * Semi-industrial transport costs are currently set to zero in the model and need confirmation. ** Biosecurity, land, and administrative cost items are currently set to zero due to lack of available data; integrating them will slightly increase actual operating costs.*

The cooperative model is primarily driven by substrate costs (36%) and labor costs (29%), two categories where efficiency gains may be achieved through improved supplier negotiations and targeted workforce training. In contrast, the semi-industrial model is heavily influenced by energy costs (43%), largely due to the use of industrial-scale drying equipment. As a result, optimizing electricity consumption, particularly through the integration of solar energy solutions or improvements in dryer efficiency, represents the principal lever for enhancing operational performance in this model.

- ### Frass

The analysis of the data shows that frass accounts for the majority of revenues in both models.

Table 4: Revenue Structure by Product

Revenue Stream	Volume/ month	Unit price	Monthly Revenue (XOF)	% of Revenue
COOPERATIVE MODEL				
BSF frass (organic fertilizer)	2,200 kg	150 XOF/kg	330,000	67.9 %
Dried larvae (animal protein)	312.5 kg	500 XOF/kg	156,250	32.1 %
Total monthly revenue – Coop			486,250	100%
SEMI-INDUSTRIAL MODEL				
BSF frass (organic fertilizer)	24,000 kg	150 XOF/kg	3 600 000	68.4 %
Dried larvae (animal protein)	3,333 kg	500 XOF/kg	1,666,667	31.6 %
Total monthly revenue – S.Ind			5,266,667	100%

Source: *Field data.*

> Frass represents approximately 68% of total revenues in both configurations, making it the primary value driver of the business. A relatively modest increase of 10 XOF/kg in the selling price of frass (i.e., +7%) results in an additional 264,000 XOF per year in revenue for the cooperative model and 2,880,000 XOF per year for the semi-industrial model. This illustrates the strong leverage effect of frass pricing on overall profitability, underscoring the strategic importance of market positioning, pricing power, and demand stability in the organic fertilizer segment.

This economic reality should inform the commercial strategy: prioritizing investment in frass quality, through improved packaging, comprehensive nutritional analysis, and organic certification, represents the most effective lever for enhancing the unit's overall viability. The production ratio is also advantageous for frass. For every 10 tons of substrate processed, the cooperative model yields approximately 2,200 kg of frass compared to 313 kg of dried larvae, corresponding to a ratio of roughly 7:1. Frass therefore constitutes the predominant product, in volumetric terms, of the bioconversion process.

Break-even Analysis

The operational break-even point (EBITDA = 0) is defined as the level of revenue at which operating expenses are fully covered. In this analysis, it is expressed in terms of the frass selling price, while revenue from larvae sales is held constant at the levels specified in the model.

Table 5: Operational Break-even Analysis

Indicator	Cooperative Model	Semi-Industrial Model
Total monthly OPEX (Year 1)	775,033 XOF	6,213,904 XOF
Current monthly revenue (Year 1)	486,250 XOF	5,266,667 XOF
Monthly gap to be covered	−288,783 XOF	−947,237 XOF
Monthly revenue achieved / monthly OPEX	62.7%	84.8 %
Current frass price	150 XOF/kg	150 XOF/kg
Required frass price (OPEX break-even)	281 XOF/kg	189 XOF/kg
Required price increase	+87 %	+26 %
Frass production volume/month	2 200 kg	24 000 kg
Unit production cost (total OPEX/kg)	~193 XOF/kg*	~184 XOF/kg*

Source*: Field data. * Unit cost calculated across total monthly output (larvae + frass) in kg/month.*

The semi-industrial model clearly emerges as the most viable option. With only a 26% increase in the frass selling price, from 150 to 189 XOF/kg, it achieves operational break-even. By contrast, chemical fertilizer prices in Côte d'Ivoire range from approximately 341 XOF/kg for subsidized products to 440 XOF/kg on the open market in 2025. A certified, well-packaged frass product could therefore credibly position itself within this price range, particularly for high-value segments such as vegetable producers and orchard farmers.

Sensitivity Analysis

The sensitivity analysis evaluates the effect of variations in the frass selling price, ranging from 100 to 300 XOF/kg, on the monthly EBITDA of both models, with all other variables held constant. Revenue from dried larvae sales is assumed to remain unchanged.

Table 6: Sensitivity of monthly EBITDA to frass selling price

Frass Price (XOF/kg)	Monthly EBITDA – Cooperative (XOF)	Cooperative Variation	Monthly EBITDA – Semi-Industrial (XOF)	Semi-Industrial Variation
100	−508,783	−76%	−2,147,237	−127%
125	−398,783	−38%	−1,547,237	−63%
150 (current scenario)	−288,783	base	−947,237	base
175	−178 783	+38%	−347,237	+63%
189 (semi-industrial threshold)	−120,383	+58%	≈ 0	break-even
200	−68,783	+76%	+252,763	+127%
250	+151,217	+152%	+1,452,763	+253%
281 (cooperative threshold)	+218	break-even	+2,147,763	+327%
300	+371,217	+229%	+2,852,763	+401%

***Source**: Green = Positive EBITDA; Red = Negative EBITDA. Author's calculations based on BM_BSFL_CIV_EN.xlsx (2026).*

> The semi-industrial model reaches operational profitability (positive EBITDA) at a frass selling price of 200 XOF/kg, representing an increase of 50 XOF/kg compared to the current price. This threshold remains below the price of subsidized chemical fertilizers (341 XOF/kg) and well below prevailing free-market prices (420–440 XOF/kg). Accordingly, this price point appears attainable, particularly for a certified, well-packaged, and reliably distributed high-quality frass product.

- ### Scenario Analysis: 5-Year P&L Projection

Three scenarios are evaluated for each model over the 2026–2031 period. The variation across scenarios is driven by changes in the frass selling price, identified in the sensitivity analysis as the primary value driver and key pivot variable.

Table 6: Scenario Comparison based on variations in frass selling price

Scenario	Frass Price	Assumption
Pessimistic	100 XOF/kg	Underdeveloped market; frass sold as a low-value by-product
Realistic (base)	150 XOF/kg	Current BioAni field price (non-certified product)
Optimistic	250 XOF/kg	Certified, packaged frass delivered to farmers

Table 7: Annual EBITDA over 5 years under three frass price scenarios

Scenario	Pessimistic	Realistic	Optimistic
COOPERATIVE MODEL – Annual EBITDA (XOF)			
Year 1	−6,101,196	−3,465,396	1,454,004
Year 2	−6,101,196	−3,465,396	1,454,004
Year 3	−6,101,196	−3,465,396	1,454,004
Year 4	−6,101,196	−3,465,396	1,454,004
Year 5	−6,101,196	−3,465,396	1,454,004

SEMI-INDUSTRIAL MODEL – Annual EBITDA (XOF)			
Year 1	−24,566,842	−11,366,842	14,433,158
Year 2	−24,566,842	−11,366,842	14,433,158
Year 3	−24,566,842	−11,366,842	14,433,158
Year 4	−24,566,842	−11,366,842	14,433,158
Year 5	−24,566,842	−11,366,842	14,433,158

***Source**: Field data. Projections are assumed to remain constant over time (i.e., no scale-up phase is incorporated). All estimates are based on the model BM_BSFL_CIV_EN.xlsx (2026) and the author's calculations.*

Note: The net income of the semi-industrial model is significantly affected by annual depreciation amounting to 51.1 million XOF, with a substantial portion recognized in Year 1, including 27 million XOF related to legal and registration expenses.

In the optimistic scenario, the semi-industrial model generates a positive EBITDA of 14.4 million XOF per year. This level of performance becomes achievable once frass is effectively positioned within the Ivorian organic fertilizer market, which is experiencing increasing demand driven by rising prices of imported chemical fertilizers.

- ### Comparative Financial Dashboard

Table 8: Key financial performance Indicators dashboard

Financial Indicator	Cooperative Model	Semi-Industrial Model
A. INVESTMENT		
Total CAPEX (equipment & infrastructure)	2,155,982 XOF	136,832,850 XOF
CAPEX in EUR (indicative)	~3,290 EUR	~208,500 EUR
Working capital requirement (BFR)	1,550,066 XOF	18,641,711 XOF
Total investment (CAPEX + BFR)	3,706,048 XOF	155,474,560 XOF
Annual depreciation	1,378,785 XOF	51,097,180 XOF*
B. OPERATIONS — YEAR 1 (realistic scenario)		
Total monthly revenue	486,250 XOF	5,266,667 XOF
Total annual revenue	5,835,000 XOF	63,200,000 XOF
Monthly OPEX	775,033 XOF	6,213,904 XOF
Annual OPEX	9,300,396 XOF	74,566,842 XOF
Annual EBITDA	-3,465,396 XOF	-11,366,842 XOF
EBITDA margin	−59.4 %	−18.0%
Annual net result	−4,844,181 XOF	−62,464,023 XOF*
C. BREAK-EVEN & FINANCIAL RETURNS		
Frass price for OPEX break-even	281 XOF/kg	189 XOF/kg
Required price increase vs current	+87 %	+26 %
NPV (WACC 18%)	−19,5 M XOF	−193,7 M XOF
IRR	Not computable (all negative cash flows)	Not computable (all negative cash flows)

***Source**: Field data. * The exceptional semi-industrial depreciation of 51.1 million XOF/year includes 27 million XOF in legal fees (Afrika Forward) and 10 million XOF in technical studies, all amortized over 12 months. The EBITDA (−11.4 million XOF) therefore provides a more accurate reflection of the underlying operational performance. 1 EUR ≈ 655.957 XOF.*

- **FINANCIAL STATEMENTS OVER 5 YEARS**

The income statements below are based on assumptions in the financial model. They reflect constant projections over a 5-year period (no gradual commercial scale-up), which constitutes a conservative estimate.

- **Cooperative model (10 t substrate/month)**

Table 9: 5-Year income statement

Profit and Loss Line	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue (CA)	5,835,000	5,835,000	5,835,000	5,835,000	5,835,000
of which frass (67.9%)	3,960,000	3,960,000	3,960,000	3,960,000	3,960,000
of which dried larvae (32.1%)	1,875,000	1,875,000	1,875,000	1,875,000	1,875,000
Total annual OPEX	9,300,396	9,300,396	9,300,396	9,300,396	9,300,396
EBITDA	-3,465,396	-3,465,396	-3,465,396	-3,465,396	-3,465,396
EBITDA margin	−59.4%	−59.4%	−59.4%	−59.4%	−59.4%
Depreciation	1,378,785	1,378,785	1,378,785	1,378,785	1,378,785
EBIT (operating profit)	−4,844,181	−4,844,181	−4,844,181	−4,844,181	−4,844,181
Financial expenses (loan)	0	0	0	0	0
Earnings before tax (EBT)	−4,844,181	−4,844,181	−4,844,181	−4,844,181	−4,844,181
Tax (CIT 25%)	0	0	0	0	0
Net profit	−4,844,181	−4,844,181	−4,844,181	−4,844,181	−4,844,181

***Source**: Field data. Cooperative model (XOF). Constant projections. CIT = 0 due to negative results*

- **Semi-industrial model (80 t substrate/month)**

Table 10: 5-Year Income Statement – Semi-Industrial Model (XOF)

Profit and Loss Line	Year 1	Year 2	Year 3	Year 4	Year 5
Revenue (CA)	63,200,000	63,200,000	63,200,000	63,200,000	63,200,000
of which frass (68,4 %)	43,200,000	43,200,000	43,200,000	43,200,000	43,200,000
of which dried larvae (31,6 %)	20,000,000	20,000,000	20,000,000	20,000,000	20,000,000
Total annual OPEX	74,566,842	74,566,842	74,566,842	74,566,842	74,566,842
EBITDA	-11,366,842	-11,366,842	-11,366,842	-11,366,842	-11,366,842
EBITDA margin	−18.0%	−18.0%	−18.0%	−18.0%	−18.0%
Depreciation	51,097,180	51,097,180	51,097,180	51,097,180	51,097,180
EBIT (operating profit)	−62,464,023	−62,464,023	−62,464,023	−62,464,023	−62,464,023
Financial expenses (loan)	0	0	0	0	0
Net profit	−62,464,023	−62,464,023	−62,464,023	−62,464,023	−62,464,023

***Source**: Field data. The exceptional annual depreciation expense of 51.1 million XOF includes 27 million XOF in legal fees (Afrika Forward consulting firm) and 10 million XOF in technical studies, all amortized over a 12-month period. Spreading these costs over 3–5 years would significantly improve the presentation of the net profit.*

- **COMPETITIVE POSITIONING OF BSF FRASS AND BSF LARVAE**

Overall financial diagnosis

This section addresses two practical questions raised by NFP and EKN: (i) To what extent is BSF frass competitive with chemical fertilizers available in Côte d'Ivoire? (ii) To what extent can dried BSF larvae substitute for imported soybean meal in poultry feed formulations?

The analysis is based on data collected from recent sources (2022–2026).

BSF frass compared with chemical fertilizers in Côte d'Ivoire

BSF frass is an organic fertilizer rich in essential nutrients. Recent analyses of black soldier fly frass indicate the following nutrient composition (dry matter basis):

Table 11: Comparison of BSF frass and chemical fertilizers in Côte d'Ivoire

Parameter	BSF Frass	Urea	NPK 15-15-15
Nitrogen (N) content	3.4%	46%	15%
P_2O_5 content	2.9%	0%	15%
K_2O content	3.5%	0%	15%
Organic matter	Yes	No	No
Soil structure improvement	Yes	No	No
pH	Neutral to alkaline	Acidifying effect	Variable
Côte d'Ivoire open market price (2025)	150 XOF/kg*	420 XOF/kg	440 XOF/kg
Côte d'Ivoire subsidized price (2024–2025)	Not subsidized	341 XOF/kg	362 XOF/kg
Import-dependent	No (locally produced)	Yes	Yes

***Source**: Field data. Frontiers in Plant Science (2025); Springer Nature (2025); Africa Fertilizer Watch, June 2025; BioAni (2026).*
** Current BioAni field price, without certification or enhanced packaging.*

The direct comparison indicates that BSF frass is marketed at a lower absolute price than chemical fertilizers (150 XOF/kg versus 341–440 XOF/kg). However, its nutrient concentration is significantly lower, which necessitates higher application rates. Consequently, the true competitiveness of frass does not lie in its cost per unit of nutrient, but rather in three key advantages:

- Simultaneous provision of organic matter, which enhances soil structure, water retention, and biological activity over the long term—benefits that chemical fertilizers do not offer.
- Demonstrated agronomic performance: several studies conducted in West Africa between 2022 and 2025 report yield increases ranging from 43% to 72% for vegetables and legumes, compared with conventional NPK fertilizer treatments applied at equivalent nitrogen rates (Frontiers in Plant Science, 2025; PMC, 2024).
- Fully local production, which reduces exposure to global price volatility and supply chain disruptions that frequently affect Côte d'Ivoire's market for imported chemical inputs.

> For vegetable farmers, perennial crop producers, and farmer organizations, a packaged, labeled, and delivered frass product could be marketed at 200–250 XOF/kg while

> remaining below the price of subsidized chemical fertilizers and simultaneously offering the additional benefits of organic matter. Such a market positioning would allow the semi-industrial BSF model to achieve operational profitability from Year 1.

- ### Dried BSFL compared with imported soybean meal

Soybean meal is the primary protein source used in poultry feed formulations in Côte d'Ivoire. A key question, therefore, is the extent to which dried BSF larvae meal can serve as a competitive alternative.

Table 12: Comparison of dried BSFL and soybean meal

Indicator	Dried BSFL	Soybean Meal (Imported)
Crude protein content	40–50%	44–48 %
Essential amino acid profile	Complete (including methionine)	Deficient in methionine
Calcium content	5–8 %	0.3 %
Fat content	25–35 %	2–3%
Côte d'Ivoire selling price (2025–2026)	500 XOF/kg	~385 XOF/kg
Cost per kg of protein	~1 111 XOF/kg	~837 XOF/kg
Additional cost per kg of protein	+33 %	—
Local production (Côte d'Ivoire)	Yes	No (imported)
Exposure to biosecurity risks	High (contaminated substrates)	Low
Regulatory framework in Côte d'Ivoire (animal feed)	Under development	Authorized
NFP recommendation (2026)	Limited use due to biosecurity risks	Commonly used

***Source**: Frontiers in Insect Science (2022); Journal of Insects as Food and Feed (2025); Springer Nature (2025); EspaceAgro / Selina Wamucii Côte d'Ivoire (2025); BioAni (2026).*

At present, dried BSFL meal is approximately 33% more expensive than soybean meal on a protein-equivalent basis (1,111 XOF versus 837 XOF per kilogram of protein supplied). This price differential is largely attributable to the still relatively high production and processing costs associated with current-scale BSF operations.

However, BSF larvae offer clear nutritional advantages for poultry. They provide a more balanced amino acid profile—particularly with respect to methionine, which is often a limiting amino acid in soybean-based feed formulations—and contain calcium levels that are 25 to 30 times higher than those found in soybean meal. This significantly reduces the need for additional calcium supplementation in compounded feeds (Journal of Insects as Food and Feed, 2025).

> Considering that the regulatory framework governing insect-based feed ingredients in Côte d'Ivoire is still under development, and in line with NFP's recommendations, BSF larvae should not constitute the primary commercial product during the 2026–2027 pilot phase. Instead, the commercial strategy should prioritize frass, which represents the dominant output, offers stronger value creation potential, and is not subject to the same regulatory and biosecurity constraints as larvae intended for animal feed.

Annex 5: Detailed roadmap

HQCP:

Phase 1 (Years 1-2):

- **Policy advocacy:**
- **Awareness campaign:** targeted at poultry and livestock (fish, pig, sheep, cattle) producers, and feed millers to producers. There is a need to inform the entire sector of the nutritional and economic value of varied HQCP products for different livestock categories and production safety measures. Engage government institutions, poultry association, cassava producers association, and processing cooperatives.
- **Governance and regulatory frameworks:** HQCP products must be recognized as distinct and legitimate feed ingredient categories. Formalizing the physical and nutritional quality standards for HQCP products is critical. Without clear processing and labelling standards, inconsistent product quality will undermine buyer confidence and fair pricing for producers.
- **Pilot sites:** Processing sites should ideally be located within 5-7.5 km of fresh peel sources/major cassava processing sites to remain within profitable transport radius (International Livestock Research Institute, 2025). Establishing a formal partnership with research institutions like ILRI for training, will guarantee that HQCP products meet optimal nutrient profiles that can be integrated into national policy and are therefore a competitive alternative to maize. Establish collaboration framework with FOANI, Koudijs/De Heus and a third feed miller and establish market linkages for raw material supply (tailored to their existing needs and blending infrastructure) and expansion of the peel supply chain.
- **Standardization and quality:** Development of standardized quality, safety, and labelling criteria for all HQCP products. Cyanide levels should remain at or below 35 ppm. Inconsistent product quality as a result of aflatoxin (20pp) risk from improper sun drying and moisture content will require training and enforceable standards to be addressed and implemented by the government in close collaboration with the sector.
- **Training and capacity building**: Training kits and technical guides validated by ILRI and HQCP product off-takers covering processing standards, equipment operation, hygiene and feed safety. Trainee selection must be deliberate, new and existing participants already engaged in the cassava industry - farmers, processors, and feed producers will be more likely to adopt the technology. A Training of Trainers (ToT) framework needs to be established with FOANI and other knowledge partners.
- **Improved cultivation techniques:** To ensure year-round supply of cassava peels. Engagement with cassava producers to adopt improved varieties and cultivation techniques and climate smart cultivation. Advocate for new varieties of cassava, adapted to different parts of the country, in collaboration with the government, cassava producers association and AFDB.

Phase 2: Scaling up and market integration:

- **Financing mechanisms:** Financing mechanisms for peel producers can only be feasible when there are off-take agreements that guarantee demand and revenue generation that can off-set credit.
- **Addressing technical bottlenecks:** Pilot and evaluate affordable storage and drying alternatives to sun drying, such as flash drying, toasting, and solar powered drying. Storage and drying is identified as the most persistent quantity and quality constraint, limiting rainy-season production and increased risk of fungal contamination.
- **Integration into certification:** enforcement of labeling standards by the government is critical. Feed millers should be encouraged to formally declare HQCP as an ingredient in feed formulations to promote market confidence; in agreement with the government and poultry sectorial organizations.
- **Regional export potential:** Due to the long shelf-life of HQCP products, there is the potential for regional exports into the Sahelian region where livestock production can be challenged with low fodder availability in the dry season. This can act as a tool for diplomacy with the AES.
- **Progress monitoring:** Deployment of a monitoring and evaluation system, across processors, feed millers, and farmers. Digital tools linking processors, aggregators, toll millers, and feed millers along the value chain can be adopted from Nigeria and integrated into the local context.

Phase 3: Institutionalization and sustained growth (Year 5)

- **Industrial scale production:** The first industrial-scale HQCP processor, using at least 10 tons of cassava peel daily, is targeted to be operational. Industrial feed mills are engaged to explore enzyme (cellulase, beta-glucanese, and xylanase) treatment of whole cassava peel mash to deal with excessive fiber (Chelangat et al., 2025) as a cost-effective route to large-volume uptake, which would significantly expand the commercial market for smaller processors supplying mash to mills.
- **Biofortification of HQCP:** Research priority in this phase should be biofortification, which involves increasing HQCP's protein content through microbial fermentations. Initial trials conducted in Nigeria suggest conversion rates of up to 60% from waste to feed ingredient on a dry matter basis (ILRI report), and higher protein content would substantially increase HQCP's competitiveness with maize in poultry and fish feed. Particularly, a mixture of cassava pulp and *Moringa oleifera* leaf meal to increase protein content, offers a low-cost method to increase nutritional value of HQCP feed (Sugiharto et al., 2020).

Organic fertilizer:

Phase 1: Preparation, Start-up, and Experimentation (Years 1–2)

Policy advocacy by the Dutch Embassy in close collaboration with FOANI focused on economic and environmental benefits of adopting the safe production and use of organic fertilizers.

- **Awareness and adoption campaign:** Target poultry and crop farmers. Focus on the use of treated poultry manure as safe and not pathogenic, as this seems to be a major misconception among farmers especially in poultry production areas. Lead with safe processing/production standards and agronomic evidence and farmer testimony, not abstract environmental arguments. Policy makers as well as farmers respond to evidence they can see and measure in their own fields, so the campaign must be built on farmer testimony and demonstrated field results, not technical reports. Particularly relevant for cocoa, cashew and cotton sectors to ensure productivity as part of the government fertilizer subsidy initiative.
- **Governance and institutional frameworks:** Development of specific regulatory framework for organic fertilizers led by the Ministry of Agriculture and producers. Organic fertilizers should be given a category of its own (separate from compost) as an emerging industry instead of being grouped together with chemical fertilizers. Therefore, the fees of 50.000 EUR required for chemical fertilizers registration and distribution should not be imposed for organic fertilizers, to encourage the building up of this infant industry, professionalization and investments for large scale production and distribution. Investment in laboratory and quality testing infrastructure is also essential, as analytical capacity to verify organic fertilizer safety and composition is currently limited in the country.
- **Pilot sites:** The identification of pilot sites, where consistent manure volumes are generated daily including poultry farms struggling with manure management such as FOANI farms with an annual volume of 100,000 tons. Sites should be selected where processing can be co-located close to the source, minimizing the cost of transporting raw, bulky, high-moisture material.
- **Standardization and quality:** Development of standardized quality and safety for organic fertilizers covering minimum nutrient content (N, P, K), maximum contaminant thresholds, moisture content, and labelling requirements. Producers must demonstrate product consistency to differentiate their product and build market credibility. Standards should align with EU Regulation 2019/1009 to preserve future international market access.
- **Training and capacity building:** The design of extension services and farmer training kits and visual supports, validated by research institutions like CNRA, ILRI and CGIAR, will support standardizing technical advice in the field. Partnering with FOANI College, and Institute National Polytechnique Félix Houphouët-Boigny (INP-HB), specifically its École Supérieure d’Agronomie (ESA). will provide a site for training and generation of initial technical data. Farmers with direct experience of organic fertilizers become strong advocates, often reporting concrete yield and quality improvements which makes on-farm demonstration plots the most effective adoption tool (GIZ, 2023).

Phase 2: Scaling Up: Monitoring, Structuring, and Expansion (Years 3–4)

- **Financing mechanisms:** Financing mechanisms from the International Finance Cooperation (IFC), local banks and The Africa Fertilizer Financing Mechanism is a special fund administered by the African Development Bank Group. The Mechanism provides innovative financing solutions required to improve production, procurement, and distribution of organic and inorganic fertilizers, and soil health interventions in Africa (Africa Development Bank, 2019).
- **Digital/progress monitoring:** The deployment of a monitoring and evaluation system, including a Management Information System (MIS) platform, will track the real impact on trained extension services personnel and farmers.
- Agronomic validation. Commission an agronomic assessment by CGIAR, Institute National Polytechnique Félix Houphouët-Boigny (INP-HB), specifically its École Supérieure d'Agronomie (ESA) in collaboration ILLRI (an internationally recognized institution who is also working on a similar topic), detailing the results from at least two seasons of demonstration plot data across the pilot zones. The assessment should produce a peer-reviewed or officially validated report confirming yield, soil health, and economic benefits, with crop-specific recommendations. This institutional validation is essential for shifting the conversation with policymakers and large commercial buyers from opinion to evidence.

Phase 3: Institutionalization and Growth (Year 5)

- **Regulatory Framework and Master Plan:** The emphasis will be on creating a national stakeholder platform to finalize a National Master Plan and regulatory framework. This will include facilitating a national soil fertility and health bill to ensure organic amendments have the same political weight as chemical fertilizers.
- **Soil health monitoring program.** A long-term soil monitoring program should be formalized to track soil organic matter, water retention, nutrient levels, etc. on farms that have used organic fertilizer for three or more years. This generates the multi-year evidence base that converts early adopters into national case study, supports policy advocacy, and provides the agronomic data needed to refine application recommendations by crop and soil type.
- **Organic Fertilizer enrichment:** involves enriching the base poultry manure with mineral nutrients or biochar to meet the specific agronomic needs of target crops (such as cacao, cashew, and cotton) and staple crops. Incorporating blended mineral-organic fertilizer products can increase product differentiation and justify premium pricing.

Proposed Success Indicators: To evaluate the effectiveness of the organic fertilizer roadmap, four key indicators have been selected.

Indicator	Target year 1-2	Target years 3-4	Target year 5
% of trained crop farmers using organic fertilizer	5%	15%	35%
Tones of poultry manure converted per year	Baseline established with 5-10tons of pelletized fertilizer	100-500 tones Dependent on investments	1000 tones Dependent on investments
Organic fertilizer units operational	2 pilot sites	1 fully commercial	including pelletizing capacity

Proposed Success Indicators: To evaluate the effectiveness of the HQCP roadmap, four key indicators have been selected.

Indicator	Target year 1-2	Target years 3-4	Target year 5
major feed millers using HQCP products	2	3	5 minimum
Tons of processed cassava peel utilized for feed	Baseline established with 50 tons per producer	Consistent supply of 50tons per month dependent on agreements and investments	Consistent supply of 100 tons per month dependent on agreements and investments
HQCP processing units operational	2	2 fully commercial	Minimum of 5 fully commercial producers

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