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A DATA-DRIVEN CIRCULAR ECONOMY ROADMAP FOR GHANA'S MANGO AND PINEAPPLE VALUE CHAINS (2025-2030)

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Executive Summary

This roadmap translates the findings of the Circular Economy Opportunity Mapping (OM) Report for Ghana's mango and pineapple value chains into a practical delivery plan for 2025-2030. The Opportunity Map is based on surveys and fieldwork in the Somanya–Akuse mango belt and the Nsawam–Akuapim South pineapple corridor, covering 81 mango producers, 38 mango traders, 130 pineapple producers, and 51 pineapple traders.

The evidence shows two value chains that are economically vibrant but still lose substantial value and create avoidable environmental and health burdens. In mango, losses are concentrated at the farm level, where 148,869 kg of fruit in the surveyed sample were recorded as lost or unutilised, equivalent to 18.8 per cent of the harvested volume. When production and marketing are considered together, about one quarter of harvested mango does not reach consumers.

In pineapple, the chain performs better on losses but still incurs value losses through farm-level spoilage, quality downgrading, and market spoilage, with total losses around 10 per cent across farm and market nodes.

Environmental effects are driven mainly by intensive use of fertiliser, pesticides, fuel and water, particularly in pineapple production. The Opportunity Map reports 76,550 kg of synthetic fertiliser used across the surveyed pineapple farms, with only 217 kg of organic fertiliser, and substantial herbicide and insecticide use, supported by 1,781,700 litres of water for chemical mixing.

The same assessment highlights fuel use and emissions as a material hotspot, including around 10,897 litres of diesel per season across pineapple production and trading, and an estimated 29.2 tonnes of CO_2 equivalent emissions.
Mango's footprint is smaller in absolute input volumes, but distribution is still fuel intensive, with mango traders using 498 litres of diesel per trading cycle and generating an estimated 1.35 tonnes of CO_2 per cycle.

The social baseline is equally important to delivery. Production is male dominated in both chains, while trading is strongly female led. Women make up about 19.8 per cent of mango producers but 97.4 per cent of mango traders, and around 15 per cent of pineapple producers but about 78.4 per cent of pineapple traders.

Youth participation in farming is reported to be low, and access to land and finance remains uneven, particularly for women operating at smaller scales in production and trading.

A major safety gap runs through the system. The Opportunity Map records zero use of personal protective equipment among surveyed mango farmers alongside high pesticide use, pointing to avoidable occupational health risks and a wider need for safer handling of agrochemicals.

Against this baseline, the roadmap sets a 2030 ambition for the mango and pineapple value chains to waste less edible fruit, use nutrients more efficiently, reduce hazardous exposure, and retain more value in local businesses and livelihoods.

It focuses delivery on the same corridors covered by the Opportunity Map, so that early action starts where volumes, markets, and existing private-sector linkages are already present, including links to major processors and buyers.

The roadmap proposes a small number of practical changes that reinforce each other.
First, it prioritises preventing edible losses and creating reliable routes for surplus fruit. For mango, this means improving harvest timing, handling, sorting, and grading, and building pathways for processing grade fruit so gluts do not automatically translate into waste.

It pairs loss reduction with value creation through community-scale drying and puree or fruit leather options, enabling a larger share of surplus to be converted into saleable products rather than discarded.

Second, it addresses input intensity and safety together, starting from composting and biofertilizer production that use farmgate and market residues, alongside integrated soil fertility and pest management support.

This is treated as both an environmental priority and a cost and resilience priority for farmers, given the scale of synthetic fertiliser use in pineapple and the very low current share of organic nutrients.

Safety is positioned as a foundation for credible change, with cooperative procurement and training intended to move producer groups towards routine PPE use and safer chemical handling.

Third, it improves logistics and packaging to reduce damage, spoilage and packaging waste. The Opportunity Map links trader discard and markdowns to handling and packaging constraints, including continued reliance on sacks and polybags.

The roadmap responds with reusable crate systems that work as a service, supported by clear return rules and basic hygiene routines, and with better shade handling and sorting space at key market and aggregation points.

Fourth, it tackles the infrastructure bottleneck that repeatedly appears in both documents. A key opportunity is the Ajankiti packhouse in the Nsawam corridor, which has been reported as inactive since 2013. The roadmap treats rehabilitation as a practical hub for aggregation, grading, and light handling upgrades, and as a place where surplus and residues can be directed into processing and compost routes rather than discarded.

Fifth, it makes inclusion a delivery condition rather than an add on. The roadmap places women led processing groups, women centred trading improvements, and youth oriented service enterprises at the centre of the business model approach, recognising that women dominate trading and are well placed to lead changes in handling, sorting and packaging systems, while youth engagement is more likely to grow through services such as logistics, crate management and residue collection.

To translate these priorities into action, the roadmap sequences delivery through four linked pilot packages that can be launched quickly and then expanded. These cover community-scale processing for surplus, packhouse and aggregation improvements, reusable crate systems, and a combined safety and soil package that brings together composting, input substitution trials, and PPE adoption.

The implementation pathway is structured so that early years focus on visible results and trust-building, followed by expansion to more sites and more formal commercial arrangements, and then replication of what works alongside routine monitoring within district systems.

The roadmap also sets clear performance intentions to guide delivery. By the end of the first delivery cycle it aims to reduce mango chain losses from around 25 per cent to 12 per cent or less, reduce pineapple losses from around 10 per cent to 6 per cent or less, raise PPE adoption among producers to at least 80 per cent within trained groups, increase the share of organic nutrients in pineapple fertiliser inputs to at least 10 per cent by mass through compost and blending approaches, and establish a portfolio of at least ten operational circular micro enterprises and cooperatives across the pilot corridors.

Finally, the roadmap emphasises that progress must be visible and measurable to sustain participation. It proposes simple monitoring focused on volumes lost, volumes diverted to processing and composting, crate circulation and return rates, input and fuel use, and safety adoption, alongside regular feedback to communities and market actors to address the mistrust and survey fatigue recorded during fieldwork.

Step 1: Vision and Strategic Intent

Vision

By 2030, Ghana's mango and pineapple value chains operate as circular systems that reduce avoidable losses, reduce hazardous exposure from agrochemicals, and increase value retention and incomes across the chain. The Opportunity Mapping Report notes that material flow analysis (MFA) identifies high post-harvest losses and chemically intensive production as the main constraints on circularity, alongside persistent gender inequities and low youth participation

The 2030 vision is that:

- Edible fruit reaches consumers through better harvest timing, handling, grading, aggregation and market coordination, reducing the volumes that spoil or are discarded. The report estimates total losses of around 25% for mango and 10% for pineapple when farm and market nodes are combined.
- Surplus fruit and unavoidable residues are treated as resources, with practical pathways for composting, biofertilizer production, and food-grade value addition, such as drying and puree, building on existing circular practices and proven industrial models.
- Farming and trading are safer, with routine use of personal protective equipment, safer chemical handling and stronger extension support on integrated soil fertility and pest management. The report records zero PPE use among surveyed mango farmers and high agrochemical use in both chains.
- Women and young people capture more value, particularly through women-led processing cooperatives and youth-oriented service businesses such as logistics, crate management, waste collection, and input services.
- Circular practices are normal business, supported by functioning infrastructure, finance and coordinated linkages between producers, traders and processors. The report highlights gaps such as an inactive packhouse and weak aggregation and handling infrastructure as barriers to reducing losses.

Strategic Goals

Goal 1: Reduce mango chain losses

- **Proposed target:** reduce total mango chain losses from about 25% to 12% or less by the end of Year 4.

- **Baseline:** MFA shows that 148,869 kg of mango was lost or unutilised at farm level, representing 18.8% of 793,640 kg harvested in the survey sample, and that about 25% of harvested mango does not reach final consumers when production and marketing nodes are combined.

- **Justification:** mango losses are the largest quantified waste hotspot in the study. At the scale observed in the sample alone, 148,869 kg is roughly 149 tonnes, or about 3,000 sacks of 50 kg each, indicating a strong opportunity for loss reduction, surplus management and value addition.

Goal 2: Reduce pineapple chain losses

- **Proposed target:** reduce total pineapple chain losses from about 10% to 6% or less by the end of Year 4.

- **Baseline:** the combined pineapple MFA reports final sales (farm plus market) of 90% and total chain losses of 10%. At farm level, losses are 81 kg per 1,000 kg harvested (8.1%), and at trading stage losses are 19 kg per 1,000 kg handled (1.9%).

- **Justification:** the pineapple chain is relatively efficient but still loses material and value, especially through gluts, quality downgrading and handling damage. Targeted improvements in handling, packaging, and aggregation can further reduce losses while protecting quality and market price.

Goal 3: Improve occupational safety and reduce hazardous exposure

- **Proposed target:** increase routine PPE adoption among producers to at least 80% trained and equipped by the end of Year 4, with basic safe handling norms adopted in producer groups.

- **Baseline:** the report states that 0% of mango producers used PPE, despite high levels of agrochemical use. The report also describes similar patterns of high chemical use and low protection across both chains.

- **Justification:** low PPE use is identified as a priority barrier to circularity and a major occupational health risk. Improving safety is also a prerequisite for scaling waste valorisation, composting, and higher-value processing in ways that protect people and communities.

Goal 4: Increase nutrient circularity in pineapple production

- **Proposed target:** increase the organic nutrient contribution in pineapple production to at least 10% of fertiliser inputs by mass by the end of Year 4, using compost and biofertiliser blending and integrated soil fertility management.
- **Baseline:** the quasi-LCA reports 76,550 kg of synthetic fertiliser applied across 130 pineapple farms, and only 217 kg of organic fertiliser, representing less than 0.3% of total nutrients applied.

- **Justification:** the report identifies pineapple as highly input-intensive, with risks of soil degradation and nutrient runoff. Composting and biofertiliser production are highlighted as viable circular entry points, supported by the presence of residue streams in both chains and existing practice examples.

Goal 5: Improve inclusive value capture for women and young people

- **Proposed target:** by the end of Year 4, establish a portfolio of bankable circular micro enterprises and cooperatives in the pilot corridors, with at least 10 operational ventures prioritising women-led processing and youth-focused services in logistics, packaging and residue management.

- **Baseline:** the social analysis reports that women are 19.8% of mango producers but 97.4% of mango traders, and that women are about 15% of pineapple producers, while about 78.4% of pineapple traders are women. Youth participation in farming is reported as low, with greater visibility in trading and transport services.

- **Justification:** the report recommends women-led processing cooperatives, youth-focused business models and gender responsive finance and skills training as core conditions for equitable circularity

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Alignment with Policy and Global Frameworks

- **National Development Plans**

This roadmap aligns with national priorities that focus on value addition, reduced post-harvest losses, enterprise development, and job creation in agriculture and agro-processing. The Opportunity Mapping Report is prepared as part of the UNIDO Ghana Circular Economy Project for agriculture and agro-processing value chains.

- **Relevant Sectoral Policies**

The roadmap supports typical horticulture and market development priorities that are explicitly discussed in the report's recommendations, including aggregation and handling infrastructure, reusable packaging, composting and strengthened producer processor linkages.

- **Sustainable Development Goals (SDGs)**

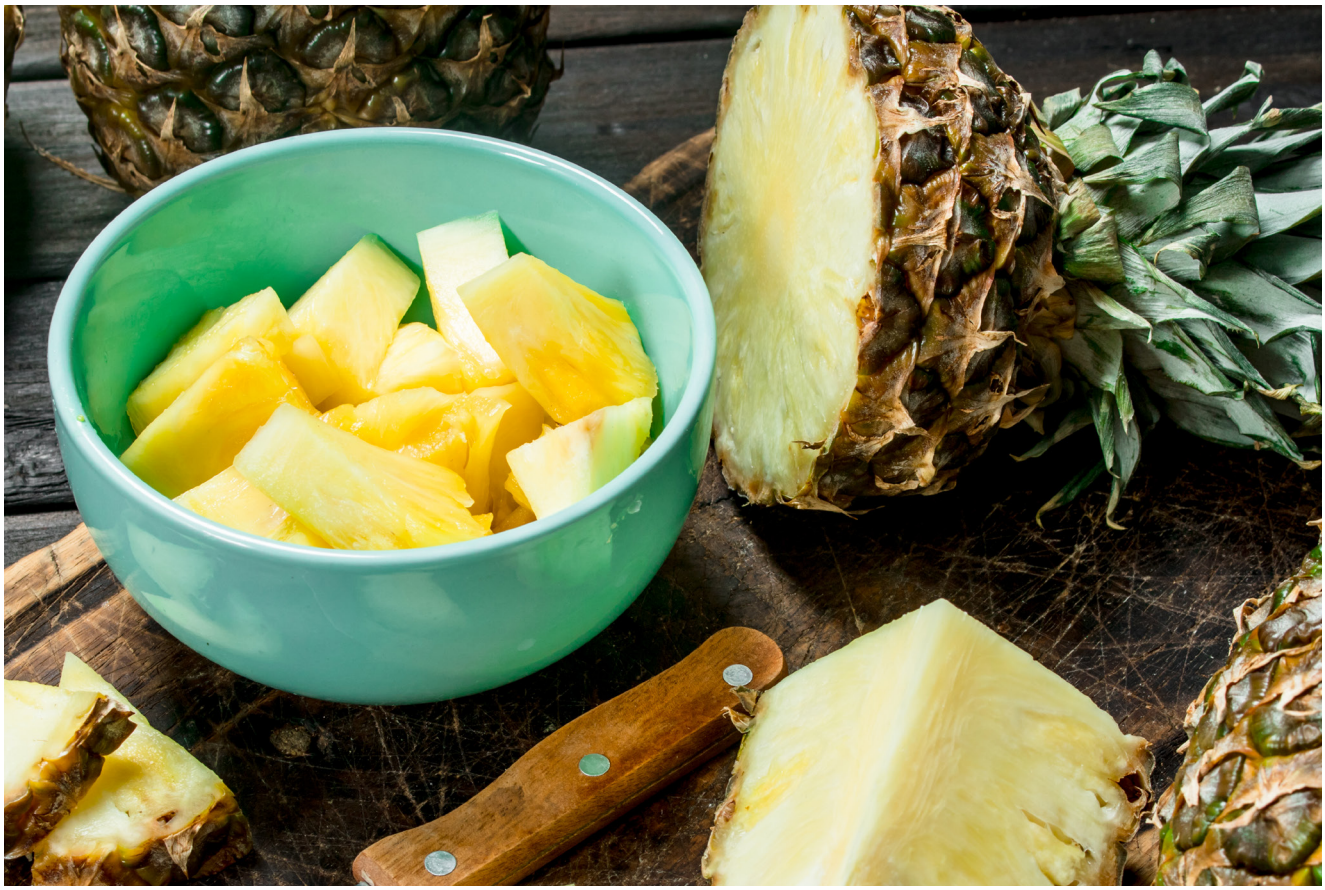
The roadmap supports SDG-relevant outcomes through reduced food loss and waste, safer production, better livelihoods, and reduced environmental pressures from inputs and emissions. The report's quantified evidence on losses, input intensity and occupational safety provides the basis for these outcomes.

- **Just Transition Principles**

The roadmap prioritises safety, decent work, and fair access to opportunities for women and young people, responding to documented gender segmentation, low PPE use, and low youth participation in farming.

Summary table

Item	Baseline signal	Year 4 intent
Mango chain losses	About 25% total losses across farm and market; 148,869 kg farm level loss in sample (18.8% of 793,640 kg)	12% or less
Pineapple chain losses	10% total losses across farm and market; 8.1% farm level loss per 1,000 kg; 1.9% trading loss per 1,000 kg	6% or less
PPE adoption among producers	0% PPE use reported among mango producers; low PPE adoption highlighted as a major barrier	At least 80% trained and equipped
Organic nutrient share in pineapple fertiliser inputs	76,550 kg synthetic fertiliser vs 217 kg organic, less than 0.3% by mass	At least 10% by mass
Women and youth enterprise roles	Women are a minority in production but dominate trading; youth farming participation remains low	Bankable circular micro enterprises and cooperatives, at least 10 operational ventures



Step 2: Baseline and Opportunity Mapping

2.1 Material flow and loss patterns (MFA insights)

The material flow analysis quantifies how fruit moves through the value chain and where it is lost or diverted along the way. The survey base covers 81 mango producers and 38 mango traders, and 130 pineapple producers and 51 pineapple traders. Evidence base for this subsection:

Mango (surveyed producers, seasonal totals)

Flow category	Quantity (kg)	Share of harvest
Sold	644,770	81.2%
Consumed in households	7,496	0.9%
Used as animal feed	505	0.06%
Lost or unutilised	148,869	18.8%
Total harvest	**793,640**	**100%**

What this indicates

- Mango production is strongly commercial, with over four-fifths sold.
- The main loss point is at farm level, with 148,869 kg lost or unutilised in the sample.

Mango (trading stage, typical weekly cycle)

Flow category	Quantity (kg)	Share of trader stock
Sold at full price	17,535	86.7%
Sold at reduced price	1,092	5.25%
Consumed by traders' households	222	1.1%
Used as animal feed	31	0.15%
Lost or discarded	415	2.05%
Total procured per cycle	**20,235**	**100%**

What this indicates

- The trading node is relatively efficient, with over 90% sold either at full or reduced price.
- Losses at trading stage are low compared with farm-level losses, but quality deterioration still drives markdowns.

Mango (combined chain efficiency)

Combined indicator	Integrated Percentage
Final consumption (farm and market)	75%
Total chain losses (farm and market)	25%

Simple equivalents for mango farm-level losses (148,869 kg)

- About 149 tonnes of fruit.
- About 2,980 standard 50 kg sacks.

- About 12 double-decker buses by weight if a bus is assumed at 12 tonnes.
- About 372,000 mangoes if an average mango is assumed at 0.4 kg.

Pineapple (per 1,000 kg harvested, farm level)

Flow category	Quantity (kg)	Share of harvest
Sold	914	91.4%
Consumed at home	5	0.5%
Used as animal feed	0	0.0%
Lost or unutilised	81	8.1%
Total	**1,000**	**100%**

Pineapple (per 1,000 kg handled, trading stage)

Flow category	Quantity (kg)	Share of trader stock
Sold to consumers	978	97.8%
Used as animal feed	3	0.3%
Lost or discarded	19	1.9%
Total	**1,000**	**100%**

Pineapple (combined chain efficiency)

Combined indicator	**Integrated** Percentage
Final sales (farm and market)	90%
Total chain losses (farm and market)	10%

What this indicates

- Pineapple performs strongly on utilisation, with low losses at farm and trading stages.
- The report links the remaining farm-level losses mainly to gluts and quality downgrading during peak periods.
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Value chain stages and typical waste streams (as mapped in the opportunity map)
Evidence base for this subsection:

Mango

- Input supply: packaging waste and expired chemicals from agro-input supply.
- Production: unharvested fruit, fallen fruit, rejected fruit, pruned branches.
- Aggregation: rejected fruit due to quality at sorting and grading.
- Trading: spoilage during storage and transport; peel waste during consumption.
- Processing: peels, seeds, trimmings; rejected fruit due to quality.
- Consumption: household organic waste including seeds and peels.

Pineapple

- Input supply: chemical containers and plastic bags.
- Production: field residues and unutilised fruits.
- Aggregation: damaged fruits and rejected sizes.

- Trading: spoilage due to heat and pressure damage.
- Processing: peels, cores and trimmings; some processors use biodigesters.
- Consumption: household organic waste.

2.2 Life cycle emissions and environmental burdens (quasi-LCA insights)

The quasi-life-cycle assessment identifies where input, water, and fuel use, and emissions are concentrated.
Evidence base for this subsection is as follows:

Mango value chain, key environmental indicators (survey-based totals)

Indicator	Value	Notes from the report
Synthetic fertiliser applied	759 kg (81 farms)	High reliance on inorganic nutrients
Organic manure applied	1,101 kg	Report notes low uptake and limited nutrient cycling
Insecticide use	211 litres	Used by 78% of surveyed farmers
Herbicide use	118 litres	Used by 54% of surveyed farmers
PPE utilisation	0 farmers reported PPE use	Major occupational health concern
Trader diesel consumption	498 litres per market cycle	Transport-related hotspot
Estimated trader emissions	1.35 tonnes CO2 per cycle	Derived from trader fuel use
Farm-level mango waste	148,869 kg	Major organic waste stream

Pineapple value chain, key environmental indicators (survey-based totals)

Indicator	Value	Notes from the report
Synthetic fertiliser applied	76,550 kg (130 farms)	Very high nutrient input intensity
Organic fertiliser applied	217 kg	Less than 0.3% of nutrients by mass
Herbicide use	755 litres	Indicates strong reliance on chemical weed control
Insecticide use	165 litres	Indicates routine chemical spraying
Water for chemical mixing	1,781,700 litres	High water demand for agrochemical application
Diesel consumption, producers	9,700 litres per season	Fuel for operations and movement
Diesel consumption, traders	1,197 litres per season	Additional distribution fuel
Estimated emissions	29.2 tonnes CO2e (producers and traders)	Carbon intensity of production and distribution
Farm-level pineapple waste	81 kg per 1,000 kg harvested (8.1%)	Report links to gluts and quality downgrading

Simple equivalents for water used for pineapple chemical mixing (1,781,700 litres)

- About 0.71 Olympic swimming pools if one pool is assumed at 2.5 million litres.
- About 10,500 bathtubs, assuming one bathtub is 170 litres.

Cross-chain comparison of environmental hotspots

Category	Mango chain	Pineapple chain
Fossil fuel use	Traders 498 litres per cycle	Producers and traders 10,897 litres per season
Synthetic fertiliser	759 kg	76,550 kg
Organic fertiliser	1,101 kg	217 kg
Pesticides (insecticides and herbicides)	329 litres combined	920 litres combined
Major waste hotspot	148,869 kg mango waste	81 kg per 1,000 kg pineapple
PPE use	0% reported among mango producers	Not quantified in the same way, but safety concerns are highlighted

2.3 Social baseline and inclusion gaps

The social and gender analysis describes who participates, who controls assets, and who is most likely to benefit from circular interventions. Evidence base for this subsection:

Producers (gender, age, education)

- Mango producers are 80.2% men and 19.8% women.
- Pineapple producers are about 85% men and 15% women.
- Mango producers are older on average; only 8.64% are under 36, compared with 18.3% for pineapple.
- Educational attainment is modest:
  - ◊ Mango producers: 30.9% have no formal education; 59.3% have basic education.
  - ◊ Pineapple producers: 19.8% have no formal education; 62.6% have a basic education.

Traders (gender, age, education)

- Mango trading is overwhelmingly female, 97.4% are women.
- Pineapple trading is also female-majority, with 78.4% of participants being women.
- Traders are largely of working age:
  - ◊ Mango traders: 26.3% are under 36.
  - ◊ Pineapple traders: 25.5% are under 36.

- Educational attainment is modest and weaker among some women traders:
  - ◊ Mango traders: 28.9% have no formal education; 60.5% have basic education.
  - ◊ Pineapple traders: 11.8% have no formal education; 70.6% have basic education.

Land access and scale (gendered constraints)

- Mango: male producers cultivate an average of 16.3 acres, compared with 3.5 acres for female producers.
- Pineapple: male producers manage an average of 10.4 acres total land and 3.8 acres

under pineapple; female producers manage 5.4 acres total land and 2.8 acres under pineapple.
- Pineapple yields per acre are higher among women in the dataset: 11,340 kg per acre for women compared with 9,980 kg per acre for men.

Labour dynamics
- Labour use is unequal at trading stage: male traders employ an average of 2.2 workers, while female traders employ about 0.6 workers, with women more reliant on unpaid family support.

Youth participation
- Youth participation in farming is described as low across both value chains, linked to land and financial constraints, and to perceived farming risks.
- Youth involvement is more visible in trading and transport services, particularly in pineapple markets.

Trust and delivery conditions
- Fieldwork reports frustration stemming from past engagements that failed to provide feedback or tangible benefits.
- This affects willingness to join collective models and willingness to engage in training and future programmes.
- Cooperatives exist but coordination is described as weak in places, limiting aggregation and shared investment in circular assets.

2.4 Current circular practices and systemic gaps

This subsection distinguishes between existing circular practices that can be scaled and structural gaps that currently block adoption.
Evidence base for this subsection:

Existing circular practices already in use
- Use of pruned mango branches for charcoal and firewood (biomass recovery).
- Use of mango seeds for propagation and rootstock.
- Purchase and use of compost derived from mango waste through established compost facilities linked to buyers.
- A near zero-waste pineapple processing model at HPW Fresh and Dry, including biodigestion, composting and animal feed production.
- Feeding damaged pineapples to pigs in some contexts.
- Reuse of pineapple crowns and suckers for planting and propagation.

Systemic gaps and constraints
- High cost of technology: limited access to dryers, shredders and composting equipment at community level.
- Infrastructure gaps: limited aggregation, grading and storage capacity; lack of cold storage; and a non-functional packhouse.
- Packaging and handling constraints: continued reliance on sacks and polybags in parts of the system, with associated mechanical damage and waste.
- Finance constraints for women traders: women dominate trading but face limited access

to capital for reusable crates and improved handling.
- Low cooperative strength and weak coordination limit aggregation, shared services, and joint investment.
- Low PPE and limited safety training: chemical exposure risks remain high and reduce readiness for improved waste handling and input substitution.
- Weak extension support for composting and organic alternatives limits the adoption of circular input systems.
- Weak producer-processor linkages: surplus fruit is not consistently absorbed during peak periods.

2.5 Circular hotspots identified (where action pays fastest)

The opportunity map identifies priority points where circular interventions can deliver measurable benefits quickly. Evidence base for this subsection:

Hotspot 1: High on-farm mango losses
- Evidence: 148,869 kg left unutilised at farm level in the sample, representing 18.8% of harvest.
- Circular opportunity: community-level drying, puree, fruit leather and decentralised processing; improved aggregation and collection centres for surplus.

Hotspot 2: Unutilised pineapple residues and farm-level losses
- Evidence: 81 kg per 1,000 kg harvested is lost or unutilised at farm level, mainly linked to gluts and quality downgrading.
- Circular opportunity: composting and biofertiliser production; feed use where appropriate; basic glut management through aggregation and structured off-take.

Hotspot 3: Trader-level spoilage and quality markdowns
- Evidence: mango traders discard 2.05% per cycle; pineapple traders discard 1.9% per 1,000 kg handled.
- Circular opportunity: reusable crates, shade handling, improved sorting and grading, and basic cooling solutions where feasible.

Hotspot 4: Underutilised infrastructure
- Evidence: the Ajankiti packhouse is reported as inactive since 2013 in the Nsawam corridor.
- Circular opportunity: rehabilitation as an aggregation, sorting and light-processing hub serving multiple value chains.

Hotspot 5: High agrochemical dependence
- Evidence: pineapple synthetic fertiliser use is 76,550 kg with very low organic inputs (217 kg), and high pesticide volumes; mango also shows substantial pesticide use and limited organic integration.
- Circular opportunity: compost hubs, manure blending, integrated soil fertility management, integrated pest management, and improved extension support.

Hotspot 6: PPE gap and chemical exposure
- Evidence: 0% PPE reported among mango producers, alongside high insecticide and herbicide use.
- Circular opportunity: cooperative procurement of PPE, safety training and compliance norms as a foundation for safer production and safer waste handling.

Hotspot 7: Packaging waste accumulation

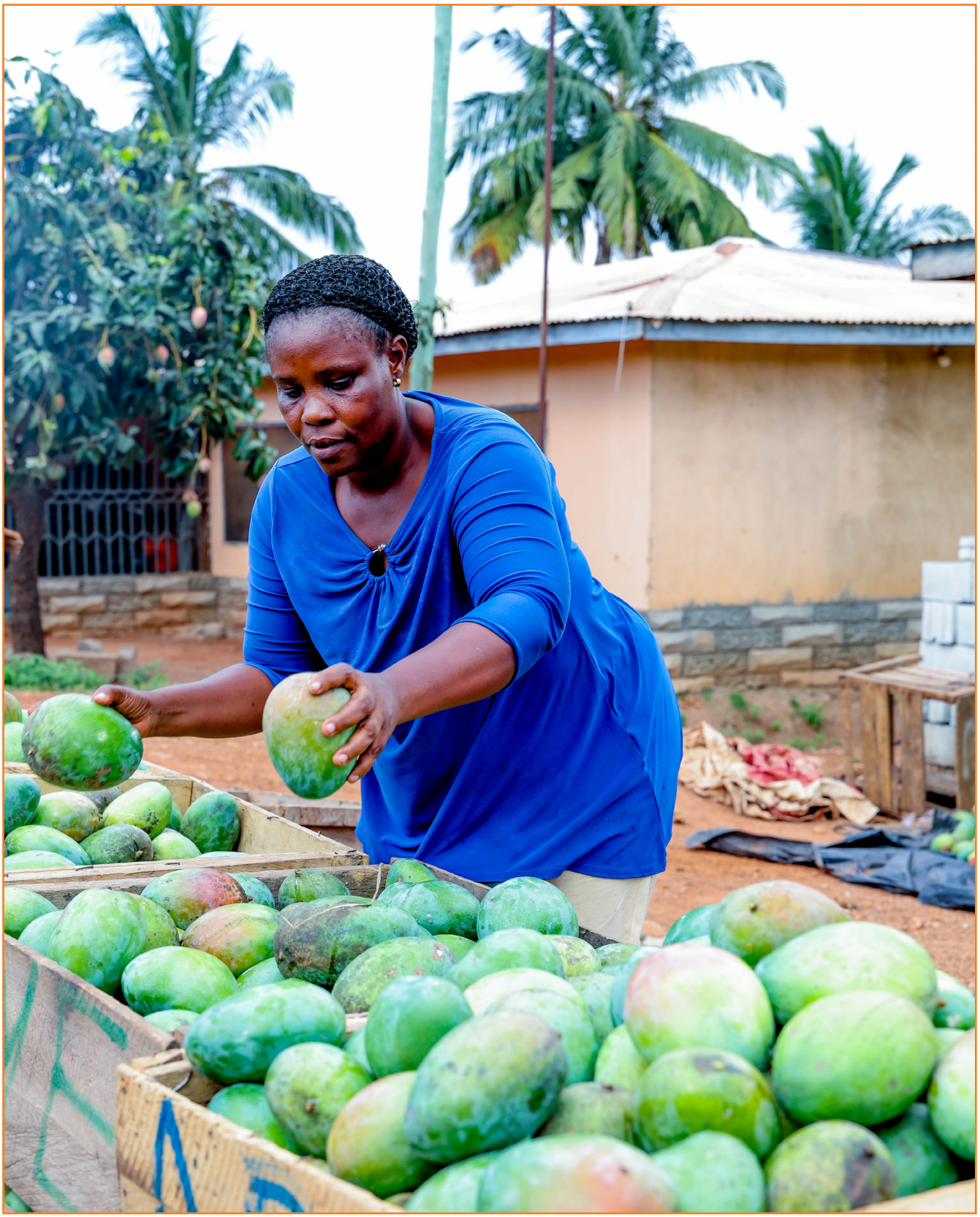
- Evidence: reliance on single-use polybags, sacks and boxes is identified as common, with associated waste and mechanical damage.
- Circular opportunity: crate banks, deposit systems, and community packaging management.

Hotspot 8: Weak producer-processor linkages

- Evidence: surplus mango and pineapple are not consistently absorbed by buying companies.
- Circular opportunity: contract-based aggregation, off-taker-linked value addition, and structured collection routes during peak season.

Step 2 summary

Baseline pain point	What it looks like in practice	Circular opportunity
Mango losses	25% total chain losses; 148,869 kg lost or unutilised at farm level in the sample	Surplus collection and aggregation, drying and puree micro-enterprises, improved grading and handling
Pineapple input intensity	76,550 kg synthetic fertiliser across 130 farms; high pesticide and water use for mixing	Compost and biofertiliser blending, integrated soil fertility and pest management, input optimisation support
Chemical exposure	0% PPE reported among mango producers; high chemical volumes in both chains	PPE provision and training, safer spraying norms, cooperative procurement and extension support
Logistics damage and packaging waste	Trader discards near 2%; reliance on sacks and polybags; heat and pressure damage	Reusable crate programmes, shade handling, simple cooling where feasible, packhouse and collection centres
Underused infrastructure	Ajankiti packhouse inactive since 2013	Rehabilitation for aggregation, sorting, grading and light processing
Water and fuel use	Pineapple chain uses 10,897 litres of diesel per season and 1,781,700 litres of water for chemical mixing	Logistics efficiency, cleaner energy options where viable, reduced chemical dependence through circular inputs
Inclusion and capability gaps	Women dominate trading but face finance constraints; modest education levels; low youth participation in farming	Women-led processing and services, youth-focused logistics and recovery services, low-literacy training, access to finance



Step 3: Prioritisation and Scope Definition

3.1 Geographic scope (from the study)

The roadmap scope follows the production and trading corridors assessed in the Opportunity Mapping Report. The purpose of keeping to these corridors is to start where production volumes, market activity, and private-sector linkages are already established and where baseline evidence is strongest.

For mango, the scope is the Somanya production belt within Yilo Krobo and Lower Manya Krobo, including Somanya, New Somanya, Akode No. 1 and Akuse Junction. These communities include both smallholders and larger producers, and they are linked to formal processors and buyers, including Blue Skies, HPW Fresh and Dry, and Bomarts Farms.

For pineapple, the scope is Nsawam and Akuapim South, including Nsawam Prison Market, Pokrom, Mangoase, and surrounding communities. These locations have active smallholder and medium-scale production alongside aggregators, traders and processors, and include a major infrastructure opportunity in the Nsawam corridor.

Table 3.1: Roadmap scope corridors and practical delivery anchors

Corridor	Commodity focus	Primary delivery locations (as studied)	Existing value chain anchors
Somanya belt (Yilo Krobo and Lower Manya Krobo)	Mango	Somanya, New Somanya, Akode No. 1, Akuse Junction	Producer communities; women-dominated trading; buyer links with processors
Nsawam and Akuapim South	Pineapple	Nsawam, Akuapim South, Nsawam Prison Market, Pokrom, Mangoase	Market aggregators and traders; processor linkages; packhouse rehabilitation opportunity

This geographic scope also reflects the report's emphasis on using existing actors and facilities as "delivery points", rather than designing interventions that rely on entirely new structures.

3.2 Value chain focus

The roadmap focuses on the parts of the value chain where the Opportunity Map shows the largest, most addressable losses and resource burdens, and where circular business models are most likely to become financially viable. It covers the full chain from inputs through to consumption, with prioritisation of the stages where interventions can be implemented and measured within 4 years.

The scope includes:

- Fresh fruit production and harvest practices, including post-harvest handling at farmgate.
- Aggregation and bulking, including sorting, grading and negotiation points.
- Trading logistics, including packaging, transport, storage and market handling.

- Processing linkages, covering both industrial off-takers and community-scale value addition where feasible.
- Residues and waste streams, including fruit rejects, peels, pulp, cores, seeds, crowns, prunings and related organic waste.
- Packaging and ancillary waste, including sacks, polybags, boxes and agro-input containers.

The scope deliberately treats infrastructure, finance, safety and coordination as part of the value chain, because the report identifies these as binding constraints on circularity adoption, particularly for women traders and smaller operators.

3.3 Prioritised opportunities (portfolio)

The prioritised opportunity portfolio is drawn from the report's identified circularity hotspots and high-potential opportunities, and then filtered through practical delivery considerations in the study corridors. The portfolio is designed to do three things at once: reduce losses, reduce harmful exposure and input dependency, and create investable roles for women and young people.

A simple selection logic is used:

- **Start where the evidence shows the largest avoidable waste or cost driver.** For example, mango farm-level losses in the survey sample total 148,869 kg, equivalent to about 149 tonnes or roughly 3,000 sacks of 50 kg each.

- **Prioritise actions that can be delivered quickly and measured.** The report highlights infrastructure and packaging improvements, composting pilots and safety training as immediate opportunities.
-
- **Design for inclusion and uptake.** Women dominate trading and will be central to logistics and packaging interventions, but face finance constraints; youth are more likely to engage through services and enterprise models.

Table 3.3: Prioritised opportunity portfolio and what each targets

Priority opportunity	What it addresses in the baseline	Where it fits best in the scope corridors
1. Community solar drying and fruit leather or puree micro-processing	High mango on-farm losses and limited surplus routes; also pineapple surplus during gluts	Mango corridor first, with pineapple-compatible product lines
2. Packhouse and aggregation revitalisation, including grading and shade handling	Lack of aggregation, sorting and handling infrastructure; quality deterioration and market-level spoilage	Nsawam corridor, linked to the existing packhouse asset
3. Reusable crate system with deposit, crate bank and return logistics	Mechanical damage from sacks and polybags; trader-level spoilage and packaging waste	Both corridors, starting in higher-volume trading points

Priority opportunity	What it addresses in the baseline	Where it fits best in the scope corridors
4. Community composting and compost-to-farm blending	Limited nutrient cycling; very low organic inputs in pineapple; large organic residue streams	Somanya and Nsawam as practical pilot hubs
5. Integrated pest management and PPE rollout through cooperatives	Low PPE use and chemical exposure; heavy reliance on insecticides and herbicides	Both corridors, beginning with organised producer groups and trader associations
6. Off-taker and processor linkage strengthening, including contract aggregation and glut absorption	Weak producer-processor linkages; surplus fruit not reliably absorbed	Both corridors, linked to existing processors and buying companies

The Opportunity Map explicitly identifies these as high-potential circular opportunities. Also, it sets out the main enabling actions needed to make them deliverable, including packhouse rehabilitation, reusable crates, composting pilots, and safety training.

Comparative measurements that support prioritisation (baseline signals)

- **Mango losses:** 148,869 kg unutilised at the farm level in the sample is roughly the weight of about 12 double-decker buses, assuming a bus weight of 12 tonnes, and about 3,000 sacks of 50 kg.

- **Pineapple fertiliser intensity:** 76,550 kg of synthetic fertiliser across 130 farms is about 1,531 standard 50 kg bags. Organic fertiliser use is 217 kg, which is about 4 bags. This gap underpins the focus on compost blending and soil fertility management.

- **Fuel use:** the pineapple chain uses 10,897 litres of diesel per season, which is roughly 218 typical car fuel tanks, assuming a 50-litre tank. Mango traders use 498 litres per trading cycle, roughly 10 car tanks.
- **Water for chemical mixing:** 1,781,700 litres is around 891,000 large 2-litre bottles, illustrating the scale of water tied to agrochemical practices.

3.4 Feasibility and impact assessment (rapid scoring)

A rapid scoring approach is used to prioritise sequencing. Scores are indicative and are intended to guide where to start, not to replace detailed business cases.

- **Feasibility (1 to 5):** delivery complexity, technology availability, local capability, institutional dependence, and time to visible results.
- **Impact (1 to 5):** likely reduction in losses and waste, reduction in health and environmental risks, cost savings, income and job creation, and inclusion outcomes for women and youth.

Table 3.4: Rapid feasibility and impact scoring

Opportunity	Feasibility (1-5)	Impact (1-5)	Evidence link to baseline and constraints
Drying and puree hubs	4	5	Directly targets the largest quantified waste stream: 148,869 kg mango unutilised at farm level; also creates enterprise roles for women and youth
Packhouse and aggregation revitalisation	3	4	Addresses known infrastructure gap; Ajankiti packhouse inactive since 2013; report identifies aggregation and handling upgrades as able to halve market-level losses
Reusable crate system	4	4	Responds to spoilage and damage associated with sacks and polybags; reduces trader-level spoilage and packaging waste; adoption is feasible with a deposit model
Composting and compost-to-farm blending	3	4	Tackles limited nutrient cycling and very low organic inputs in pineapple; responds to high synthetic fertiliser intensity and organic residue availability
IPM and PPE rollout through cooperatives	5	4	Baseline safety gap is severe; 0% PPE use reported among mango producers; training and procurement can begin quickly with organised groups
Contracted glut absorption and strengthened off-taker linkages	3	3	Responds to weak producer-processor coordination; requires negotiation, trust, and consistent quality and aggregation

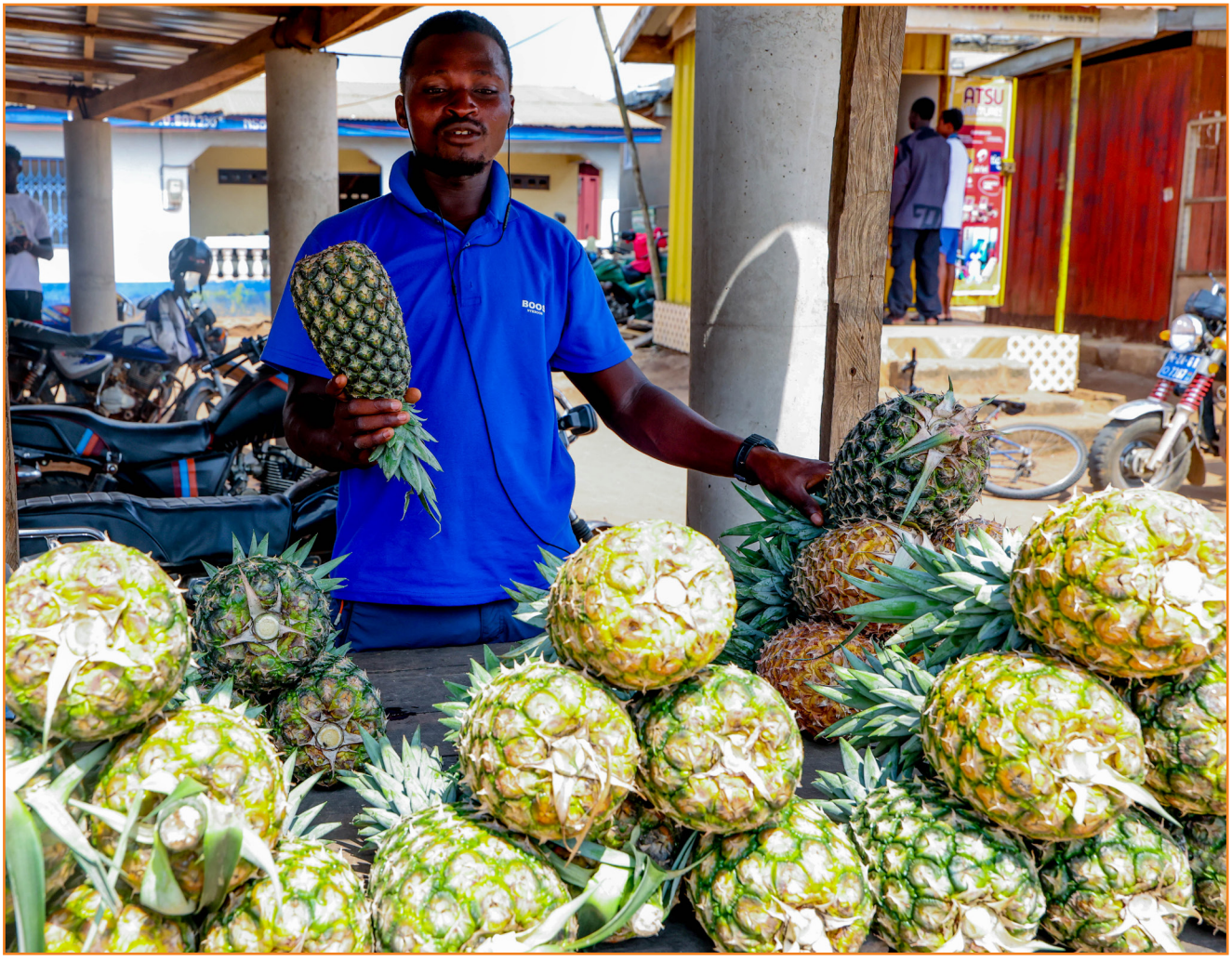
Implication of the scoring

The highest-priority items combine high impact with quick delivery. Drying and micro-processing is prioritised because it addresses the largest quantified loss stream and can be piloted with modest infrastructure. PPE and safer spraying is prioritised because the baseline gap is extreme and improvements can be delivered rapidly through training and cooperative procurement. Reusable crates and aggregation upgrades are prioritised because they reduce damage and markdowns across both fruits and support any future scaling of processing and off-take agreements. Compost blending is prioritised because it is the most direct route to reducing the very high synthetic input dependency in pineapple, but it requires more structured operations and extension support than a PPE rollout.

Step 3 summary

Table 3.5: First actions and the rationale

Do first	Why first
Drying and puree hubs, alongside PPE and safe handling	Addresses the largest mango loss stream and the most serious safety gap, with quick and visible results in the pilot corridors
Reusable crates and aggregation improvements, including shade handling	Reduces mechanical damage, spoilage and markdowns, and improves quality for both domestic and processor markets
Composting pilots and compost-to-farm blending	Begins to reduce dependence on synthetic inputs and improves soil health, starting from a clear baseline gap in pineapple nutrient cycling



Step 4: Stakeholder Mapping and Engagement Design

4.1 Key stakeholders and roles (minimum viable coalition)

Delivering circular outcomes in mango and pineapple depends on a coalition spanning production, trade, processing, local institutions, and finance. The Opportunity Mapping Report shows that the value chains are active but fragmented, with limited shared infrastructure and weak coordination in some cooperatives. For delivery, the minimum viable coalition needs to bring together the actors who control product quality, volumes, movement, and waste streams, alongside the institutions that can support training, standards and local planning.

At the core are the value chain actors, who make day-to-day decisions that determine losses, waste, safety and quality.

- **Input suppliers** (agro-input shops, fertiliser distributors, chemical shops, seedling and planting material suppliers, cooperative nurseries)
  Their role is to support safer, more efficient use of inputs, including better handling of agrochemicals and improved access to planting materials. They also influence packaging waste and management of expired chemicals and containers at the start of the chain.

- **Producers** (smallholders and larger farms)
  Producers are the primary decision-makers on harvest timing, field handling, sorting, on-farm storage, and the management of residues such as fallen fruit, prunings and rejected produce. They also carry the greatest occupational exposure risk where PPE use is low and chemical volumes are high.

- **Aggregators and transport actors** (community aggregators, company agents, truck loaders, transporters)
  Aggregation is where quality is set for processors and where rejection rates often rise due to grading, bruising and delays. Company agents already operate in aggregation for firms such as Blue Skies, Bomarts, and HPW. They are therefore essential to any improvements in sorting, grading, and bulking, as well as to the establishment of predictable collection routes for surplus fruit.

- **Traders and market actors** (roadside sellers, market traders, mobile traders, wholesalers)
  Traders are central to packaging choices, handling practices, storage decisions and the visibility of waste streams at market level. The report's social analysis shows that trading is overwhelmingly women-led, particularly in mango, making women traders a practical entry point for reusable crates, sorting, and waste recovery systems.

- **Market managers and market authorities** (including the main trading points in the study corridors)
  Market management influences whether there is space for shade, sorting tables, crate banks, hygiene rules, and waste segregation. These actors are critical for enabling low-cost improvements that reduce damage and spoilage, and for agreeing workable arrangements for collection of residues.

- **Processors and off-takers** The report identifies major processors and buyers, including Blue Skies, HPW Fresh & Dry, and Bomarts Farms, as anchors in both value chains. Their role is to provide clear quality specifications, structured procurement, and practical routes for surplus fruit and residues. HPW's near-zero-waste pineapple model is particularly important as an operational reference point for what is feasible when residues are treated as resources.

Alongside these core actors are delivery and enabling stakeholders, who enable scaling beyond pilots.

- **District assemblies and local government**
  The report recommends integrating circularity metrics into district agricultural planning and monitoring. District-level leadership is therefore needed to convene actors, allocate space for market improvements, align local infrastructure plans, and support consistent oversight of agreed standards.

- **Extension services and technical advisers**

  Extension officers and technical partners are needed to deliver farmer field schools and practical training on post-harvest hygiene, composting, integrated soil fertility management, and pesticide safety. This is especially important given the report's findings on low PPE use and modest educational levels, which require practical, demonstration-led training.

- **Farmer-based organisations, cooperatives and trader associations**

These groups are the natural vehicles for bulk purchasing, shared assets, and collective action, but the report notes that some cooperatives are underutilised and that coordination is weak in some places. Strengthening these organisations is therefore both a stakeholder task and an engagement objective, because they are needed for crate banks, joint composting investments, and aggregation arrangements.

- **Finance and savings groups** (VSLA, susu, cooperative credit unions, banks, private lenders)
  The report highlights limited access to finance for women traders as a key barrier to the adoption of circular assets such as crates, small dryers, and storage boxes. The coalition must therefore include finance channels that can provide affordable working capital and asset finance, with products that reflect women's role in trading and their typical business sizes.

- **Youth groups and service enterprises**

Youth participation in production is described as low, with stronger visibility in trading and transport services. The roadmap therefore treats youth as priority delivery partners for logistics, crate management, residue aggregation, seedling production, and micro-enterprise operations linked to drying and composting.

- **Convenors and research partners**
  The work is situated within the UNIDO Ghana Circular Economy Project and

implemented with KNUST, with field engagements and surveys forming the evidence base. Their role in the roadmap is to support coordination, evidence-led design, and practical monitoring and learning across sites.

Comparative baseline signals that shape stakeholder design

Stakeholder engagement needs to reflect who holds influence and who is most exposed to barriers:

- In the study sample, mango trading is almost entirely women-led (37 of 38 traders), while mango production includes far fewer women (16 of 81 producers). Pineapple shows a similar pattern, with women a minority in production and a clear majority in trading.
- Cooperative structures exist but are not consistently delivering coordination, limiting their ability to support shared assets and collective approaches.
- Trust is a delivery constraint in its own right, with reported survey fatigue and scepticism in Somanya and surrounding communities linked to past engagements that did not provide feedback or tangible benefits.

Table 4.1: Stakeholder roles and what each group enables

Stakeholder group	Primary role in the roadmap	What they enable in practice
Producers	Loss reduction at farmgate; safe production; residue management	Harvest timing, sorting, safe chemical handling, residue supply for composting
Traders and market actors	Handling quality, packaging choices, waste visibility	Reusable crates, improved storage and hygiene, market residue segregation
Aggregators and transport	Consolidation, grading and movement	Faster collection routes, fewer rejects, coordination with processors
Market managers	Space, rules, hygiene and logistics	Shade structures, sorting areas, crate banks, basic storage and hygiene rules
Processors and off-takers	Specifications, markets, residue valorisation models	Contract aggregation, surplus absorption, technical guidance and standards
District assemblies	Convening and integration into plans	Local infrastructure support, oversight, integration of indicators
Extension services	Practical training and advisory	Field schools, compost and ISFM guidance, pesticide safety and PPE training
Cooperatives and associations	Collective action and shared assets	Bulk purchasing, crate bank governance, joint investment in circular assets
Finance groups	Working capital and asset finance	Access to crates, dryers, small equipment; tailored products for women
Youth groups	Delivery capacity and new services	Logistics, crate return systems, residue aggregation, micro-enterprises
UNIDO and KNUST	Convening, technical support, learning	Evidence-led design, monitoring, cross-site learning and coordination

4.2 Engagement platforms

The engagement design is built around two practical realities highlighted in the report. First, coordination is currently fragmented and needs simple, repeatable mechanisms. Second, trust is not guaranteed: communities reported frustration where previous engagements did not bring feedback or clear benefits, which reduces willingness to participate in collective models and new initiatives. The engagement approach therefore, prioritises visible results, feedback loops, and participation that is easy to sustain alongside daily work.

The roadmap uses three engagement platforms. Each platform is designed to produce a concrete output that directly supports implementation.

Platform 1: Value Chain Forums (quarterly)

These forums provide a regular space for joint problem-solving and decision-making among producers, traders, aggregators, market managers, processors, district representatives, and extension services. The purpose is to share progress, agree on actions, and make decisions openly so that participants can see what has changed and why.

Practical design features include:

- rotating venues across the main corridor markets and production communities so attendance does not always fall on the same groups
- a short, plain-language performance update covering losses, handling issues, safety actions and pilot progress
- a public "actions and commitments" register that records what each stakeholder group has agreed to do before the next forum
- a simple feedback segment so participants can correct assumptions and raise delivery issues early

Success depends on credibility. The report's finding of survey fatigue means that the forum must provide visible "you said, we did" feedback, not just presentations.

Platform 2: Listening sessions and live demonstrations

These sessions are designed to help adoption by showing practical changes rather than explaining them in abstract terms. They are most useful at the point where new practices are being introduced, such as reusable crates, grading routines, composting methods, and PPE use.

A typical session should be short and practical, with:

- a live demonstration of a specific practice (for example, crate loading compared with sack handling, or compost maturation checks)
- a small number of agreed measures that people can see immediately (for example, reduced bruising rates in a trial batch, or time saved during handling)
- a brief discussion on what would make the practice workable at scale, including cost, time, and space constraints

Where comparative measurement is helpful, demonstrations should use direct comparisons that people recognise. For instance, crate pilots can compare damage outcomes in two batches of equal weight, and compost pilots can compare the number of 50 kg bags of compost produced from a known volume of residue over a defined period. This supports practical learning and reduces resistance based on uncertainty.

Platform 3: Regional design labs (co-design of business rules)

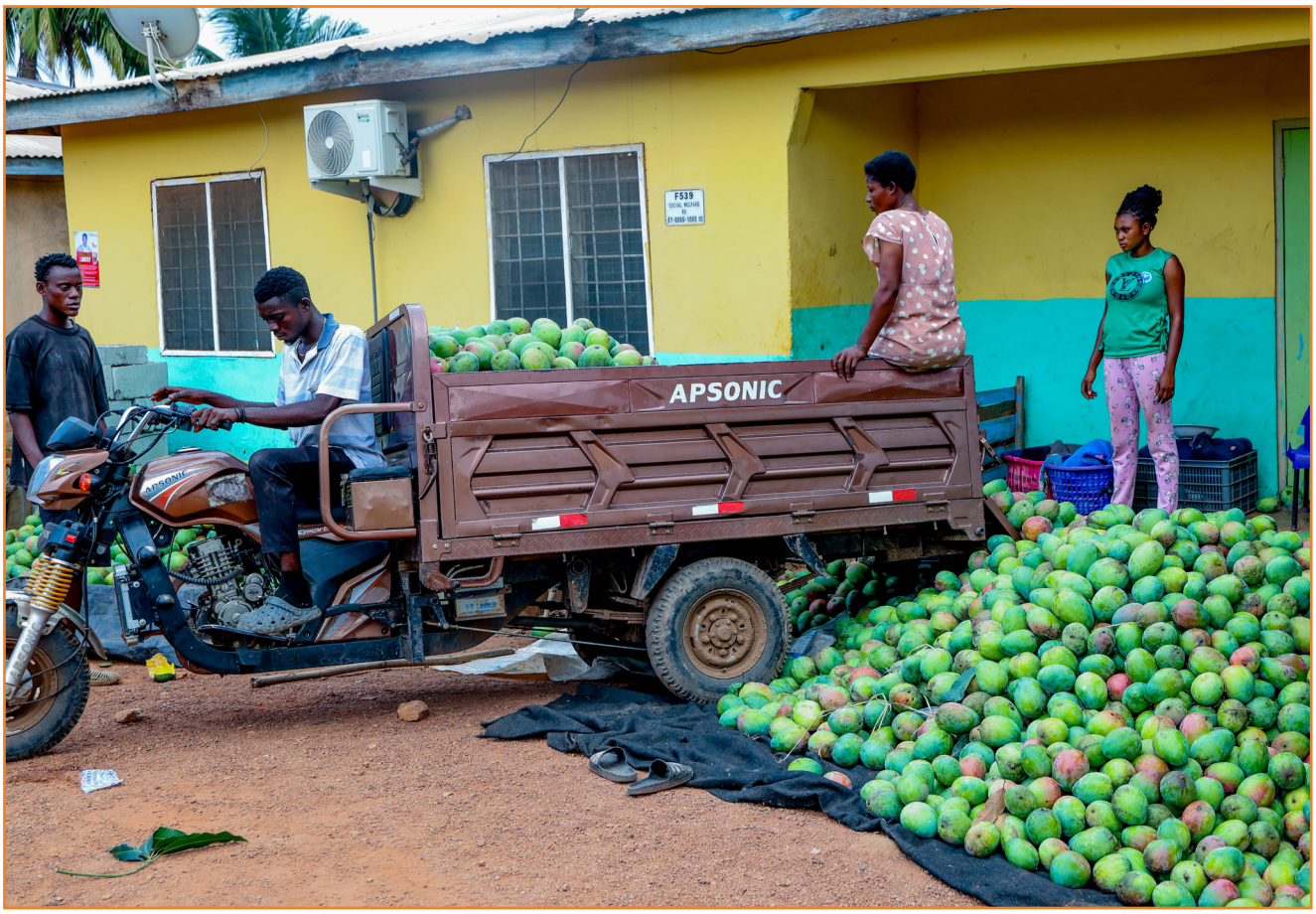
Design labs are small working sessions that turn the roadmap into workable operating rules. They are needed because several priority interventions depend on shared systems that will fail without agreed rules. This is most relevant for:

- crate deposit values, responsibilities for cleaning, and return logistics
- compost pricing, quality expectations, and distribution routes
- residue collection routes and schedules that do not disrupt market operations
- off-taker arrangements, including basic quality grading and the handling of surplus volumes
- cooperative procurement arrangements for PPE and key inputs

The output of each design lab should be a short written agreement that people can use, including a pilot charter, a basic standard operating procedure, and a named focal person per stakeholder group. This directly addresses the report's findings on weak coordination and the need for strengthened institutional and private sector linkages.

Table 4.2: Engagement platforms and intended outputs

Platform	Primary purpose	Typical participants	Practical outputs
Quarterly Value Chain Forums	Transparency, coordination and joint decisions	Producers, traders, aggregators, market managers, processors, district and extension	Actions register; decisions on priorities; public progress update
Listening sessions and demonstrations	Adoption and learning by doing	Target user groups, especially traders and producer groups; extension support	Trial results; refinements to practices; early problem-solving
Regional design labs	Workable business rules for shared systems	Smaller delegated group from each stakeholder type	Pilot charters; agreed rules for deposits, pricing and routes; signed MOUs



Step 4 summary

Platform	Purpose	Proof of success
Value Chain Forums	transparency and coordination	stable attendance and visible follow-through on actions
Listening sessions and demonstrations	adoption and feedback	repeat participation and documented practice changes
Regional design labs	workable business rules	signed agreements and pilots launched with clear responsibilities

Step 5: Pillars, Levers and Enablers

5.1 Strategic pillars (tailored to fruit)

The Opportunity Mapping Report shows that circularity for mango and pineapple will not be achieved through a single intervention. It requires a small number of practical pillars that work together: preventing edible losses, turning unavoidable residues into value, reducing hazardous exposure and chemical dependence, improving handling and packaging, ensuring women and young people can participate in higher-value roles, and strengthening coordination and data so progress can be measured and trusted.

Pillar 1: Loss-to-Value

The first priority is to stop edible fruit becoming waste. The report quantifies this as a major efficiency loss, particularly in mango, where around one quarter of harvested fruit is lost across farm and market nodes, and where the producer survey alone recorded 148,869 kg of unutilised fruit at the farm level. 148,869 kg is about 149 tonnes, roughly 3,000 sacks of 50 kg each.

What changes on the ground is a shift from "sell what you can and discard the rest" to "plan for all grades". This typically means:

- better harvesting, sorting and grading at farmgate and aggregation points
- collection routes or centres that can move surplus quickly
- clear pathways for processing-grade fruit, so gluts do not automatically become waste

The report identifies solar drying, puree production and fruit leather as practical routes for mango, with pineapple also compatible where surplus arises.

Pillar 2: Circular nutrients and safer production

The second pillar closes nutrient loops and reduces toxic risk. The report's environmental assessment shows very high reliance on synthetic inputs and very low organic nutrient cycling in pineapple, alongside extensive pesticide use in both chains. Pineapple producers applied 76,550 kg of chemical fertiliser across the survey sample, which is about 1,531 standard 50 kg bags. Organic fertiliser was 217 kg, roughly 4 bags of 50 kg. This scale difference is a key reason the roadmap prioritises composting and blended fertiliser approaches rather than expecting an immediate full switch.

This pillar also addresses occupational health. The report records zero use of personal protective equipment among surveyed mango farmers, alongside high volumes of insecticide and herbicide use. It concludes that this creates acute and chronic risks and that PPE provision and safety training are foundational for any credible circular transition.

What changes on the ground is practical and visible:

- composting and biofertiliser production using market-level and farmgate fruit waste
- training in integrated soil fertility management and integrated pest management
- cooperative procurement models for PPE and safer input handling norms

These are presented in the report as priority circular-input-system opportunities that reduce chemical dependency and improve soil health.

Pillar 3: Circular logistics and packaging

The third pillar focuses on the movement and protection of fruit, because handling damage and heat exposure drive spoilage and reduce prices. The report highlights trader-level discard rates of 2.05% per mango trading cycle and 1.9% per 1,000 kg for pineapple, and also flags a heavy reliance on sacks and polybags, which increase mechanical damage and create packaging waste.

This pillar is about shifting to:

- reusable crates supported by workable deposit-return arrangements
- shade handling and basic post-harvest infrastructure at collection and market points
- improved sorting and grading routines that protect quality and reduce markdowns

The report notes that infrastructure measures such as aggregation space, sorting tables, reusable crates and cooling options have the potential to reduce market-level losses by up to 50%, which is why logistics and packaging are treated as a core pillar, not an add-on.

Pillar 4: Inclusive enterprise

The fourth pillar ensures circularity creates fairer economic value, particularly for women and young people. The report's social analysis shows that women dominate trading but are under-represented in production, and that many women traders operate with limited access to finance and equipment. It also shows that educational levels are modest, especially among women traders, which affects business record-keeping, access to formal finance, and the adoption of improved technologies.

The report recommends practical solutions that match these realities:

- women-led processing cooperatives and skills training in solar drying and low-cost processing technologies
- youth-focused business models in waste collection, seedling production and market logistics
- gender-responsive microfinance packages, particularly for women traders and smallholder women farmers

A useful delivery rule is that inclusion is most likely when the intervention fits existing roles. For example, women already manage a large share of market handling, so crate banks and market-level sorting can create higher-margin roles for women traders if paired with suitable finance. Youth are more visible in trading and transport, so logistics, return systems and residue aggregation are more realistic early entry points than expecting large numbers of new youth farmers.

Pillar 5: Data and coordination

The fifth pillar ensures decisions are based on evidence and that communities see progress. The report describes fragmented coordination and underutilised cooperatives, as well as survey fatigue and mistrust, where communities have not received feedback or tangible benefits from past engagements. For circular programmes that depend on collective action, this is a delivery risk that must be actively managed.

This pillar focuses on:

- simple measurement of volumes, losses, residues collected and products produced

- clear feedback loops so participants can see results and adjust practice
- integration of circularity indicators into district agricultural planning and monitoring

The report explicitly recommends integrating circularity metrics into district planning and strengthening institutional and private-sector collaboration to support a sustained transition.

Table 5.1: Strategic pillars and the baseline problem each addresses

Pillar	Baseline signal from the Opportunity Map	What the pillar delivers
Loss-to-Value	Around 25% mango and 10% pineapple fail to reach consumers; 148,869 kg mango unutilised in the producer sample	Less edible loss, more value addition, predictable surplus routes
Nutrients and safety	Pineapple fertiliser 76,550 kg vs 217 kg organic; zero PPE use among mango producers; high pesticide volumes	Compost and blends, safer practices, reduced chemical dependency
Logistics and packaging	Trader discard around 2%; packaging waste from sacks/polybags; weak handling infrastructure	Crates, shade handling, grading routines, reduced damage and markdowns
Inclusive enterprise	Women dominate trading but have limited capital; youth farming participation low; low literacy affects uptake	Bankable women and youth enterprises, accessible training, appropriate finance
Data and coordination	Fragmented coordination, underutilised cooperatives, mistrust and survey fatigue	Simple MRV, feedback, and integration into district planning

5.2 Policy instruments (practical levers)

The report's recommendations imply that policy support should focus on low-regret, delivery-friendly instruments that reduce the upfront costs of circular assets, set basic quality and safety standards, and create dependable markets for circular products.

Micro-grants for shared assets

Short-term recommendations include rehabilitating the Ajankiti packhouse, deploying reusable crates, and establishing pilot composting facilities in Somanya and Nsawam. Each of these requires modest shared infrastructure that individual traders or smallholders cannot finance alone. Micro-grants, matched grants, or district-supported shared assets are appropriate when the benefits accrue to many actors and when collective systems need to be tested quickly.

Standards and simple certification rules

The report repeatedly highlights quality deterioration, safety gaps, and low-literacy constraints. Light-touch standards can help without imposing high compliance burdens. Priority areas are:

- crate hygiene and handling rules for market use
- drying quality specifications that are practical for community enterprises
- compost maturity and contamination checks so compost is safe and effective
- basic pesticide safety and PPE minimum requirements for producer groups

These measures support safe, tradeable products and reduce risk for buyers and consumers.

Procurement and market-making

The report's medium- and long-term recommendations include scaling solar drying and strengthening circular processing for dried fruits and concentrates. Public procurement can support demand for dried fruit snacks and safe compost, particularly where schools or public institutions can buy locally produced goods that meet basic standards. This helps new enterprises to move beyond one-off sales and into stable contracts.

Table 5.2: Practical policy levers and what they unlock

Instrument	What it unlocks	Examples linked to the Opportunity Map
Micro-grants or matched grants	Early assets and shared infrastructure	Packhouse reactivation, crate banks, composting pilots
Standards and simple compliance rules	Safer, tradeable circular products	Crate hygiene, drying specs, compost maturity, PPE minimums
Procurement and market-making	Stable demand for new circular products	Dried fruit snacks, compost supply agreements

5.3 System enablers

The report is clear that adoption barriers are not mainly about willingness. They are about cost, infrastructure, finance, safety, coordination and skills. System enablers are the practical tools that make it easier for people to adopt the new behaviours and business models.

Local language and low-literacy training tools

The report highlights low educational attainment among many value chain actors, particularly women traders, and recommends training approaches suited to low-literacy environments. This means practical demonstration-led modules, visual standard operating procedures, and simple checklists for sorting, drying hygiene and safe spraying, rather than theory-heavy materials.

Mobile tracking and simple reporting

Because mistrust and survey fatigue were observed, feedback must be rapid and visible. The report recommends integrating circularity metrics into district planning; this is more feasible when data collection is light-touch. Mobile or WhatsApp-based templates can capture basic volumes such as:

- kilograms harvested and sold
- kilograms rejected or unutilised
- kilograms of residues collected for composting or processing
- numbers of crates in circulation and return rates

These logs do not need to be complex to support credible monitoring and programme learning.

Strengthened extension and cooperative capability

Weak extension support and low cooperative strength are identified as barriers. Enablers therefore include refresher training for extension teams on composting, integrated soil fertility management and pesticide safety, and practical support to farmer-based organisations to manage shared assets and bulk procurement. This is also aligned with the report's call for

stronger institutional linkages and private sector collaboration, including structured off-take arrangements.

Table 5.3: System enablers required for scale

Enabler	Why it is needed (baseline constraint)	What it looks like in practice
Modular training in local languages	Low literacy limits uptake of improved technologies and record-keeping	Visual SOPs, demonstration days, short modules for traders and farmers
Mobile data tracking tools	Coordination is fragmented and trust is fragile	WhatsApp templates, simple logs, quick feedback to communities
Extension and cooperative strengthening	Weak extension support and underutilised cooperatives constrain shared systems	Training of trainers, cooperative asset rules, bulk buying for PPE and inputs
Processor and district coordination	Surplus not reliably absorbed; planning needs indicators	Off-take agreements, district integration of CE indicators

Step 5 summary

Pillar	What changes on the ground
Loss-to-Value	Surplus becomes a product stream, supported by collection, grading and processing routes
Nutrients and safety	Compost and blends replace some synthetic inputs; PPE and safer practices become routine
Logistics and packaging	Less bruising and spoilage through crates, shade handling and basic standards
Inclusive enterprise	Women and young people access higher-margin roles, supported by finance and practical training
Data and coordination	Decisions are based on simple volume data and visible feedback, not anecdote

Step 6: Pilot Design and Execution

These pilots are designed to test and scale the priority circular opportunities identified in the Opportunity Mapping Report. Each pilot is anchored to a quantified baseline problem (losses, input intensity, safety gaps, infrastructure constraints) and is structured so that results can be measured and shared with communities and decision-makers.

Table 6.0: Pilot portfolio and delivery focus

Pilot	Primary purpose	Lead delivery locations (from study corridors)	Main value chain nodes	Primary KPI
Pilot 1. Drying and fruit leather hubs	Convert surplus into saleable products and reduce mango losses	Somanya belt (Yilo Krobo and Lower Manya Krobo)	Farmgate, aggregation, processing	Tonnes of surplus converted into products
Pilot 2. Packhouse and aggregation revitalisation	Reduce damage and spoilage through better handling, grading and storage	Nsawam corridor (Ajankiti packhouse)	Aggregation, trading, light processing	Reduction in market-level losses and markdowns
Pilot 3. Crates-as-a-Service	Reduce mechanical damage and single-use packaging through reusable crates	Markets and collection points in both corridors	Trading, logistics	Share of volume moved in crates
Pilot 4. Safety-to-Soil package	Reduce chemical risk and shift nutrient inputs using compost, blends, IPM and PPE	Somanya and Nsawam	Production, residue recovery	Synthetic fertiliser replaced and PPE adoption

Pilot 1: "Surplus-to-Snack" Drying and Fruit Leather Hubs (community scale)

Context and rationale

The Opportunity Mapping Report identifies mango as the highest-loss commodity in the study areas. Producer-level MFA recorded 148,869 kg of mango left unutilised, representing 18.8% of the harvested mango in the survey sample. This is about 149 tonnes, or roughly 3,000 sacks of 50 kg. The report lists community-level solar drying, puree production and fruit leather as high-potential circular opportunities to convert this surplus into products and income.

Pilot objective

Establish 2 to 3 community-operated drying and fruit leather hubs that can process and dry mango (and, where relevant, pineapple) surplus into safe, saleable products during peak periods.

Pilot design (what will be put in place)

Each hub is designed as a small, shared enterprise with clear governance and measurable throughput.

- **Physical set-up:** a shaded work area, washing and preparation tables, slicing tools, drying units (solar and where needed hybrid back-up), basic packaging tools, and secure storage. The report recommends solar-drying microenterprises as a medium-term intervention and identifies post-harvest infrastructure constraints that this pilot directly addresses.

- **Grading system:** three grades are used so that value is retained appropriately:
  - ◊ fresh market grade
  - ◊ processing grade (for puree and juice routes)
  - ◊ drying grade (ripe, sound fruit suitable for drying and fruit leather)

- **Product lines:** dried mango slices, fruit leather, and puree where feasible, aligned with the report's identified valorisation options.

Key activities (delivery steps)
The pilot follows a practical, repeatable sequence:

- Site selection and hub governance: select 2-3 locations based on surplus availability, trader access, and community readiness. Establish a simple cooperative or enterprise management structure with named roles.
- Training and food safety basics: short, practical training on grading, hygiene, drying procedures, and packaging. The report notes modest educational levels and recommends accessible, practical skills training.
- Supply coordination: traders act as supply coordinators, producers supply agreed grades, and aggregators support scheduled deliveries during peak periods.
- Buyer routes: two routes run in parallel:
- local retail and institutional outlets (including schools and shops where procurement allows)
- processor-linked off-take for surplus products where specifications can be met

Success criteria and targets
The pilot success metrics are designed to be easy to measure and meaningful.

- **Surplus captured during peak months:** at least 30% of would-be wasted mango in the pilot communities is converted into product. Using the survey baseline, 30% of 148,869 kg is about 44,700 kg, roughly 44.7 tonnes, or about 894 sacks of 50 kg.

- **Enterprise ownership:** women and youth groups hold operational control and are able to demonstrate basic business records and compliance with hygiene routines. The report recommends women-led processing cooperatives and youth-focused models for value addition and logistics.

- **Quality acceptance:** a minimum acceptance rate agreed with offtakers, measured through rejection logs and corrective actions.

Stakeholders and roles

- **Producers:** supply agreed grades and participate in harvest and handling improvements.
- **Traders:** coordinate volumes, timing, and market routes; women traders are a key delivery group in this chain.
- **Processors/off-takers (Blue Skies, HPW Fresh & Dry, Bomarts):** provide specifications and mentor quality assurance where possible.
- **District and extension teams:** support training, basic compliance, and monitoring.

Pilot 2: Packhouse and aggregation revitalisation, including grading and shade handling

Context and rationale

The Opportunity Mapping Report identifies infrastructure gaps as a core driver of quality downgrading and losses in both value chains. It highlights the Ajankiti packhouse in the Nsawam corridor as inactive since 2013, describing this as a critical missed opportunity. The report recommends rehabilitating the packhouse as a multi-value chain aggregation and light-processing hub and notes that infrastructure measures, such as sorting, grading, reusable crates, and basic cooling, could reduce market-level losses by up to 50%.

Pilot objective

Reactivate the packhouse function as an operational aggregation and handling point that improves quality, reduces mechanical damage, and creates a structured place for surplus routing (including links to drying, processing, and composting).

Pilot design (minimum viable rehabilitation)

This pilot focuses on "minimum viable infrastructure" that can be delivered quickly and then improved once utilisation is proven.

- **Core handling improvements:** shade structures, washable sorting and grading tables, clear signage of grades, washable crates, and simple record boards for volumes received, graded, rejected, and dispatched.
- **Basic cooling options:** where feasible, introduce low-energy options such as evaporative cooling or small cool rooms, as recommended in the report.
- **Scheduled aggregation days:** set predictable days and times for deliveries, grading, and dispatch to reduce delays and heat exposure.

Key activities (delivery steps)

- Packhouse governance agreement between market actors, district assembly, and key user groups.
- Training on grading standards, hygiene, and handling protocols, aligned to processor specifications.
- Operating rules for access, fees (if any), cleaning responsibilities, and dispute resolution.
- Linking the packhouse to Pilots 1, 3 and 4, so that rejects and residues are chanelled into drying or composting routes rather than being discarded.

Success criteria and targets
The pilot measures success in terms of quality protection and throughput.

- **Reduced market-level losses and spoilage:** measurable reduction in discard and visible spoilage in the markets served. The report indicates that market-level loss reduction of up to 50% is feasible with the recommended measures; the pilot should treat 30 to 50% reduction as the performance range to test and confirm locally.

- **Reduced markdowns:** fewer sales at reduced price due to deterioration, measured through trader logs.

- **Faster offtake in peak season:** shorter time between arrival and dispatch, reducing exposure to heat and pressure damage.

Comparative measurement (why this matters)
If market-level losses are halved in the served corridor, the effect is similar to "getting back" one extra saleable fruit out of every two that would otherwise be lost at market stage. For traders operating on tight margins, this is the difference between a profitable week and a loss-making one.

Pilot 3: "Crates-as-a-Service" (deposit crate bank and reverse logistics)

Context and rationale
The Opportunity Mapping Report identifies heavy reliance on single-use polybags, sacks, and boxes, resulting in mechanical damage and packaging waste. It proposes reusable crates, community packaging banks and deposit-return systems as practical circular solutions. It links these directly to reducing trader-level spoilage and losses.

Pilot objective
Introduce a reusable crate service that reduces bruising and spoilage, lowers packaging waste, and improves quality outcomes for both domestic and processor markets.

Pilot design (how the crate system works)
The pilot is structured as a service, not a one-off distribution of crates, because the value comes from rotation, cleaning and return.

- **Crate bank:** a managed inventory held at a market or packhouse node, with simple tracking (crate counts in and out).

- **Hygiene procedures:** basic cleaning and drying routines, with responsibility clearly assigned.

- **Deposit-return model:** a small deposit collected at issue and refunded at return, to minimise losses and keep the system self-sustaining.

- **Reverse logistics:**

a youth-run collection service using motor tricycles or scheduled collection days.

Key activities (delivery steps)

- Select pilot markets and routes with high volume and high damage risk.
- Agree crate handling rules with traders, loaders, and transporters.
- Train users in loading practices that reduce pressure damage.
- Establish return schedules and collection routes that fit trading patterns.

Success criteria and targets

- **Adoption:** at least 60% of pilot trade volume moved in crates by the end of Year 2.
- **Crate retention:** crate loss rate of 5% or less per quarter, measured through inventory checks.
- **Quality improvement:** reduced visible bruising and fewer discards, measured through trader discard logs and reduced-price sales records.

Comparative measurement (why this matters)

For every 1,000 kg handled, baseline traders discard about 19 kg of pineapple, and a comparable discard rate is observed for mango traders in cycle terms. A modest improvement that prevents even half of that discard is roughly the equivalent of saving a full extra crate of fruit per tonne handled, depending on crate size. This is a tangible saving for traders and a visible proof point for adoption.

Pilot 4: Compost and biofertiliser blending plus IPM and PPE, the "Safety-to-Soil" package

Context and rationale

The Opportunity Mapping Report identifies pineapple production as highly input-intensive. The quasi-LCA records 76,550 kg of synthetic fertiliser applied across surveyed pineapple farms, compared with 217 kg of organic fertiliser, less than 0.3% of nutrient inputs by mass. It also identifies a serious occupational safety gap: 0% of mango producers report using PPE, alongside high pesticide volumes. The report lists composting, biofertiliser production, integrated soil fertility management, integrated pest management, and PPE training as priority interventions.

Pilot objective

Reduce hazardous exposure and begin shifting input dependence by converting fruit residues into compost or biofertiliser, using blended fertiliser trials on farms, and embedding PPE and safer spraying norms through cooperative delivery.

Pilot design (what will be delivered together)

This pilot is delivered as a package because safety, composting and input change are linked in practice.

- **Residue collection routes:** market and farmgate residues collected for composting, with simple separation rules to reduce contamination.
- **Composting system:** windrow or box composting, with basic maturity checks and recordkeeping. The report recommends pilot composting facilities in Somanya and Nsawam using market-level and farmgate fruit waste.

- **Blending trials:** trial plots that test compost blends replacing 10 to 30% of synthetic fertiliser application, with simple measurement of yield and crop performance.

- **PPE procurement and training:**

cooperative bulk purchasing of PPE and practical safe-handling training, delivered through farmer field schools as recommended.

Comparative measurement (what the targets mean)

Using the pineapple baseline:

- 10% replacement of the synthetic fertiliser baseline is about 7,655 kg, roughly 153 bags of 50 kg.
- A 30% replacement is about 22,965 kg, roughly 459 bags of 50 kg each.

These comparisons help farmers and decision-makers understand the scale of change expected in practical terms.

Success criteria and targets

- **Reduced synthetic fertiliser use in trial groups:** measurable reduction linked to compost blending, with evidence from input logs and plot records.

- **PPE adoption:** at least 80% PPE adoption in pilot farmer groups, measured through training attendance, spot checks and routine use during spraying. The baseline safety gap is documented as extreme.

- **Compost quality and uptake:** compost produced meets agreed maturity standards and is used on farms, rather than accumulating without a buyer.

Stakeholders and roles

- **Producers and cooperatives:** host composting sites, run field trials, manage PPE procurement.

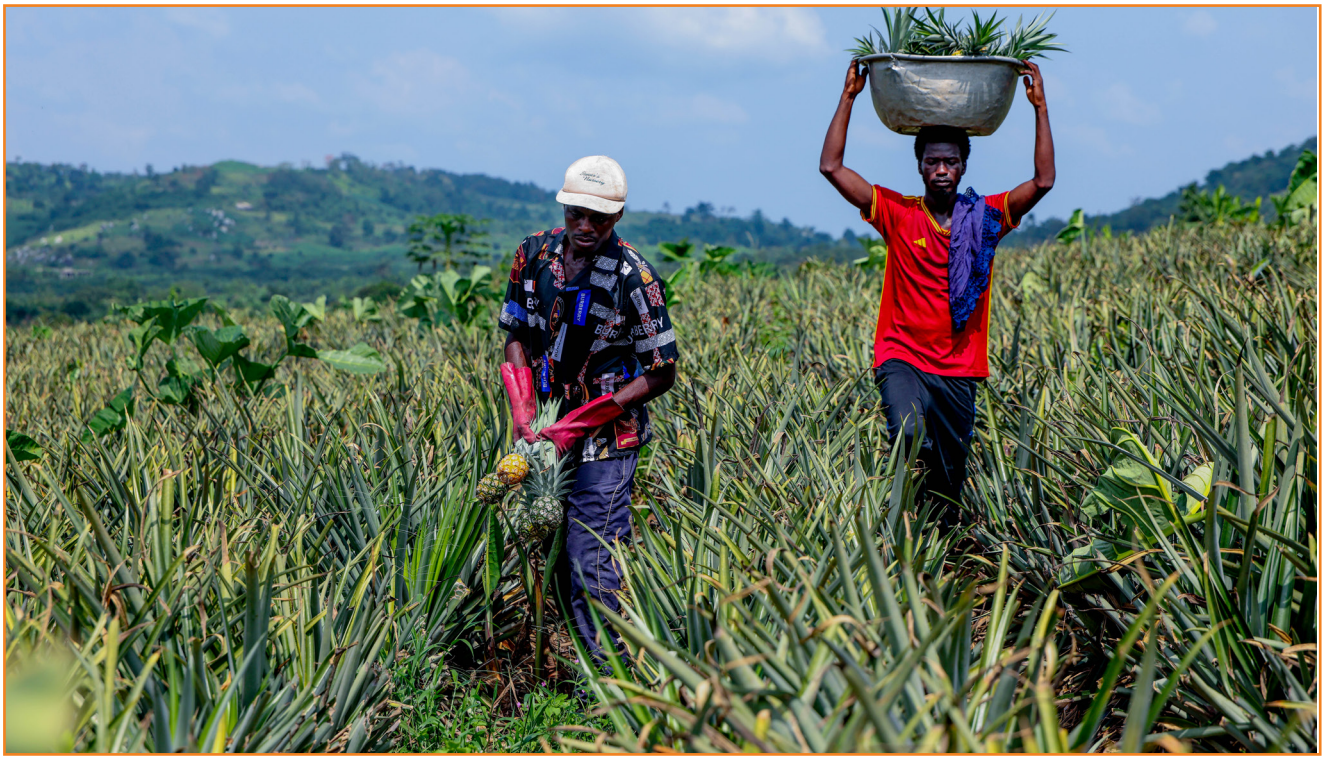
- **Extension services:** deliver farmer field schools on safety and integrated management practices.

- **Processors and market actors:** support residue sourcing and, where relevant, public-private compost distribution models linked to processors such as Blue Skies, as recommended.

Step 6 summary

Table 6.1: Pilot performance indicators and circular loops

Pilot	Primary KPI	Supporting indicators	Circular loop activated
Drying and fruit leather hubs	Tonnes of surplus converted into products	Rejection rates; sales volumes; women and youth ownership	Loop B (value addition)
Packhouse and aggregation	Reduction in market-level losses and markdowns	Throughput volumes; time to dispatch; grade compliance	Loop B plus logistics
Crates-as-a-Service	Share of volume moved in crates	Crate return rate; discard rate; reduced-price sales	Loop C (packaging reuse)
Safety-to-Soil package	Synthetic fertiliser replaced and PPE adoption	Compost tonnes produced; trial plot performance; training coverage	Loop A (nutrient cycling)



Step 7: Action Plan and Implementation Pathways

This action plan sets out a practical pathway from pilots to scale, using the sequencing already recommended in the Opportunity Mapping Report
and designed to respond to the main delivery constraints, including weak post-harvest infrastructure, limited finance (especially for women traders), low PPE use, and local mistrust driven by "survey fatigue".

The plan is structured in three phases:

- **Foundation (Years 1 to 2):** pilots are launched, standard operating procedures are established, and early monitoring begins.
- **Consolidation (Years 2 to 3):** pilots are expanded across markets and communities, and formal commercial arrangements are put in place.
- **Scaling (Years 3 to 4):** the strongest models are replicated, monitoring is integrated into district routines, and enterprises are prepared for investment.

Short-term (Years 1 to 2): Foundation

In the first two years, the priority is to start activity quickly, show early results, and build confidence. The report notes that mistrust can reduce willingness to adopt innovations and participate in training, so early delivery needs to be visible and practical.

Implementation in this phase should focus on five linked actions.

1. Launch the four pilots and agree operating rules from day one.
This aligns with the report's short-term recommendations, including packhouse reactivation, reusable crates, pilot composting facilities, and farmer field schools on pesticide safety and PPE. The key output in Year 1 is not just equipment or infrastructure; it is a working system with basic governance, roles, and routines that people trust.

2. Rehabilitate and operationalise the Ajankiti packhouse as a visible "delivery hub".
The report identifies the Ajankiti packhouse as inactive since 2013 and recommends rehabilitating it in the short term. The minimum viable package in Years 1 to 2 should prioritise shade, sorting tables, washable surfaces, basic record boards, and clear grading routines. A practical way to communicate the benefit is to link it to the report's estimate that these measures could reduce market-level losses by up to 50%. Put simply, where fruit is being lost due to heat and pressure damage in the market, the ambition is to roughly halve that loss through better handling and faster offtake.

3. Deploy reusable crate pilots in the highest-volume trading points.
The report recommends a short-term reusable crate programme and links heavy reliance on sacks and polybags to mechanical damage and waste. In Year 1, the aim should be to prove that a deposit-and-return crate bank can operate reliably, with cleaning routines and

simple tracking. In Year 2, the aim is to increase the share of traded fruit moved in crates and reduce both spoilage and reduced-price sales linked to bruising.

4. Establish pilot composting facilities in Somanya and Nsawam and begin blending trials. The report recommends pilot composting facilities in Somanya and Nsawam in the short term, and highlights the scale of synthetic fertiliser use in pineapple, at 76,550 kg. That is roughly 1,531 bags of 50 kg fertiliser, which is a useful comparative measure when communicating the scale of input dependence. Compost pilots should be sized and operated so that output can be weighed, bagged, and recorded, and then used in small blending trials with basic agronomic support.

5. Deliver safety training and PPE procurement at scale, using farmer field schools. The report documents zero PPE use among surveyed mango producers and recommends farmer field schools on pesticide safety and PPE in the short term. The Year 1 priority is to make PPE adoption normal practice in pilot producer groups, supported by cooperative bulk purchasing where possible.

A non-negotiable element in Years 1 to 2 is feedback to communities. Fieldwork reported frustration where past engagements did not provide feedback or tangible benefits. A simple and credible approach is to publish short "what changed this quarter" updates through the Value Chain Forums and market noticeboards, using plain numbers such as tonnes of fruit handled through improved routes, crates in circulation, and bags of compost produced.

Medium-term (Years 2 to 3): Consolidation

Years 2 to 3 focus on expanding coverage and turning pilots into dependable services. The report recommends medium-term actions, including solar drying micro-enterprises, mobile aggregation services, low-interest financing for women and youth, and expanded collection centres with shade and basic infrastructure.

Three implementation pathways matter most in this phase.

1. Expand crate banks and aggregation days across markets.
By this stage, crate handling rules and deposit-return arrangements should be stable. The focus shifts to geographic spread: more markets, more routes, and better discipline around returns and hygiene. This is also the stage to institutionalise "aggregation days" so that volumes are predictable for processors and bulk buyers.

2. Scale compost blending plots and put "compost purchase agreements" in place.
Moving from pilots to scale requires dependable demand. Compost purchase agreements can be designed as simple arrangements between compost sites, cooperatives, and groups of farmers. A useful comparative measure for communication is to express progress as "bags of fertiliser replaced". If a blending programme replaces 10% of the pineapple synthetic fertiliser baseline recorded in the report, that is about 7,655 kg, or 153 bags of 50 kg. If it reaches 30%, that is about 22,965 kg, or 459 bags. These are tangible numbers that farmers and district leaders can track.

3. Formalise glut-absorption agreements with processors and off-takers. The report identifies weak producer-processor linkages and surplus not absorbed by buying companies, and recommends strengthening institutional and private sector collaboration, including outgrower schemes and expanded subcontracting with firms such as HPW, Blue Skies, and Bomarts. In Years 2 to 3, the aim is to convert informal relationships into workable commercial arrangements: agreed quality grades, scheduled collection, basic dispute resolution, and reliable payment expectations.

At the same time, Years 2 to 3 are the point to bring in tailored finance. The report recommends low-interest financing for women and youth engaged in processing and logistics, recognising that women dominate trading but often have limited capital. In practice, this can be delivered through a mix of VSLA and susu channels, cooperative credit routes, and targeted microfinance products that match the scale of trading businesses.

Long-term (Years 3 to 4): Scaling

Years 3 to 4 focus on replication and institutional integration. The report's long-term recommendations run to 3 to 7 years, so the Year 3 to 4 focus is best described as "locking in the foundations for longer-term scale".

In this phase, implementation should concentrate on four priorities.

1. Replicate proven hubs and services across additional districts.

Where drying hubs and collection centres have demonstrated reliable throughput and quality acceptance, replication should follow a standard package: minimum equipment list, staffing roles, hygiene routines, and simple reporting.

2. Integrate circular economy indicators into district agricultural planning and monitoring.

The report recommends integrating circular economy indicators into district planning and monitoring frameworks. In Years 3 to 4, the practical step is to adopt a small set of indicators that district teams can maintain without external consultants, such as: tonnes of fruit lost, tonnes of fruit diverted to processing, crates in circulation and return rate, compost produced, and PPE coverage in producer groups.

3. Move from pilot funding to bankable enterprise models.

4. This means building investor-ready numbers: throughput, unit costs, pricing, cash flow, and evidence of demand. The report's emphasis on women-led processing cooperatives and youth-focused business models should translate into enterprises with clear ownership structures and credible records, not informal activity.

5. Prepare longer-term system coordination.

The report recommends establishing a national circular horticulture platform and strengthening export-oriented circular processing for dried fruits, concentrates and powders. In Years 3 to 4, the realistic deliverable is not full national roll-out. Still, a designed and tested coordination model based on what has worked in the districts, with clear roles for government, processors, research partners, and finance institutions.

Phased summary table

Phase	Timeline	Key outputs
Foundation	Years 1 to 2	Pilots running; packhouse reactivated; crate and compost pilots operational; PPE training scaled; basic SOPs and early monitoring in place
Consolidation	Years 2 to 3	Expanded crate banks and collection centres; compost purchase agreements and blending plots scaled; formal off-taker arrangements in place; targeted finance activated for women and youth
Scaling	Years 3 to 4	Replication across districts; circular indicators integrated into district monitoring; enterprises become investment-ready; national coordination model designed using district learning

Step 8: Monitoring, Reporting, and Verification (MRV)

MRV is used to show, in plain terms, whether the roadmap is reducing losses, reducing harmful exposure, improving resource efficiency, and creating fairer economic opportunity. It is designed to be proportionate: simple enough to run in real markets and farming communities, yet robust enough for district planning, private-sector partners, and future investment cases.

8.1 Environmental KPIs

Environmental KPIs track what happens to fruit, residues, inputs, water and fuel. The baseline comes from the Opportunity Mapping Report's material flow analysis and quasi-LCA, which provide quantified starting points for mango and pineapple.

A practical approach is to use a small set of "headline" indicators for reporting, and a slightly wider set of "supporting" indicators for managing pilots and diagnosing problems.

Table 8.1: Headline environmental KPIs

Indicator	Baseline	Target by Year 4	Unit	Frequency	Source and method	Verification approach
Mango loss rate (farm and market combined)	25%	12% or less	Percentage of total harvest	Seasonal (each harvest season)	Seasonal MFA refresh in pilot corridors	Reconcile producer and trader surveys with aggregation and hub records
Pineapple loss rate (farm and market combined)	10%	6% or less	Percentage of total harvest	Seasonal	Seasonal MFA refresh	Reconcile producer and trader surveys with market and packhouse records
Synthetic fertiliser used in pineapple production (pilot group)	76,550 kg across the survey sample	10% to 20% reduction in pilots	Kilograms	Per season	Farm input logs plus receipts	Spot checks of receipts and farm input records
Diesel use in pineapple chain (pilot corridor)	10,897 litres per season	Reduction through logistics efficiency	Litres	Per season	Fuel logs for key operators	Cross-check fuel logs with transport records
Compost produced (pilot sites)	Not central-ised	Tonnes per year reported by site	Tonnes	Monthly and annual	Weighing at site, bag counts	Random weight checks and site inspections

Comparative measures for communication

- 76,550 kg of pineapple synthetic fertiliser is about 1,531 standard 50 kg bags. A 10% reduction is about 153 bags, and a 20% reduction is about 306 bags.
- 10,897 litres of diesel per season is about 218 typical car fuel tanks, assuming a tank size of 50 litres.
- Mango losses at the producer level recorded in the survey, 148,869 kg, are equivalent to about 2,980 sacks of 50 kg.

To support the headline indicators, the pilots should track a small number of additional operational measures. These are not intended for public reporting every time, but they help managers understand what is driving change.

Table 8.2: Supporting environmental measures

Supporting measure	Why it matters	Unit	Where collected
Mango farm-level unutilised fruit	Shows whether on-farm handling and surplus routes are working	Kilograms and Percentage	Producer logs, hub intake records
Trader discard and reduced-price sales	Distinguishes spoilage from quality downgrading	Kilograms, Percentage, and value where possible	Trader cycle logs
Water used for chemical mixing in pineapple	Tracks water burden linked to chemical dependence	Litres	Producer input logs
Pesticide volumes used (mango and pineapple)	Tracks exposure risk and potential contamination risks	Litres	Producer input logs and training follow-up
Reusable crates in circulation and return rate	Confirms whether packaging reuse is working as a system	Crate count and return Percentage	Crate bank inventory
Residues diverted to composting or processing	Shows whether waste is becoming a resource	Kilograms	Packhouse and hub records

A practical note on the water indicator: the baseline for pineapple chemical mixing water is 1,781,700 litres. That is about 891,000 large 2-litre bottles, which helps show why reducing chemical dependence also reduces water demand.

8.2 Economic KPIs

Economic KPIs show whether circularity is improving livelihoods and whether pilot models are becoming investable. The Opportunity Mapping Report provides strong physical baselines (losses, inputs, fuel) but does not provide a complete monetary baseline across actors. For that reason, Year 1 MRV should establish the financial baseline through simple sales and cost logs linked to the pilots.

Evidence base used for Step 8.2 (value chain structure, trading patterns, and constraints affecting finance and adoption):

Table 8.3: Core economic KPIs

Indicator	Baseline position	Target by Year 4	Method	Frequency
Value generated from "rescued fruit"	Low and not systematically recorded	Increasing share of income for hub operators and suppliers	Hub sales records, buyer receipts, and payout sheets	Monthly and seasonal
Trader markdown share	Present, linked to quality deterioration	Reduced markdown share in pilot markets	Trader cycle logs capturing full-price and reduced-price volumes	Monthly
New circular micro-enterprises	Few formalised ventures	At least 10 scalable ventures operating across pilot corridors	Registry plus revenue logs	Quarterly
Unit cost of handling and wastage	Not standardised	Measurable reduction for participating traders and aggregators	Compare costs before and after adoption (crates, aggregation days)	Quarterly
Finance mobilisation	Fragmented and limited for small operators	Clear mix of grants, loans, and working capital accessible to women and youth	Finance partner records and enterprise accounts	Quarterly

Comparative measures for communication

- A target of 10 new ventures is the equivalent of one functioning circular enterprise per main market or cluster in the study corridors, if distributed evenly. This helps keep the ambition tangible and grounded.

- Reducing markdowns is often felt more quickly than reducing total waste. Even a small fall in reduced-price sales can be the difference between breaking even and making a profit for a trader operating on narrow margins.

Economic MRV should also record who benefits. This is essential for demonstrating fairness and for building confidence among community participants.

8.3 Social KPIs

Social KPIs track safety, inclusion, and participation in higher-value roles. They also track whether delivery approaches are building trust, because trust is a practical condition for collective systems such as crate banks, shared hubs and cooperative procurement.

Evidence base used for Step 8.3 (gender roles, PPE baseline, education and youth participation constraints):

Table 8.4: Social KPIs

Indicator	Baseline	Target by Year 4	Method	Frequency
PPE use during spraying (producer groups)	0% reported among surveyed mango producers	80% or more in pilot farmer groups	Spot checks, short surveys, training attendance and repeat checks	Quarterly and during spray periods
Women in higher-margin roles	Women dominate trading but have limited access to assets and processing roles	Women-led processing groups and women-managed services operating in pilots	Membership lists, leadership roles, and revenue shares	Quarterly
Youth participation through services	Youth participation in farming reported as low	Youth-run services established (logistics, crates, residue collection, hub operations)	Enterprise tracking and service contracts	Quarterly
Training accessibility	Education levels are modest, particularly among women traders	Training materials and delivery methods working for low-literacy contexts	Simple post-training checks of practice adoption	Quarterly
Trust and participation	Survey fatigue and mistrust reported in some communities	Participation sustained and feedback loops working	Forum attendance, repeat participation, and community feedback logs	Quarterly

Comparative measures for communication

- Moving from 0% PPE use to 80% means four out of five farmers in the pilot groups are consistently using PPE during spraying. That is an easy figure to communicate and check.

- The gender pattern is stark: in the survey, women are a minority of producers but the large majority of traders. This means inclusion cannot be measured only at the farm level; it must be measured across trading, logistics, and processing roles as well.

8.4 Data collection tools

MRV will only work if data collection is light-touch and useful to the people providing the data. The Opportunity Mapping Report used mobile tablet surveys and recommends integrating circularity indicators into district planning. The roadmap MRV builds on that by using simple tools that can be run by hubs, market actors, extension services and district teams.

Evidence base used for Step 8.4 (methodology and recommendation to integrate circularity indicators into district planning):

Data tools should include:

- Mobile logs using simple forms or WhatsApp templates for volumes harvested, sold, discarded, and diverted to hubs or composting.
- Pilot operational logbooks for hubs, crate banks, packhouses and compost sites, with daily totals and weekly summaries.
- Receipts and transaction records for key inputs such as fertiliser and fuel, and for product sales.
- Periodic audits and spot checks led by extension teams and district focal points to validate reported data.
- Seasonal surveys to refresh the MFA baselines and capture changes in behaviour and outcomes.

A simple reporting rhythm helps avoid overload:

- Weekly: crate bank inventory, hub intake and output, compost batches started.
- Monthly: sales, markdown share, PPE checks, residues collected and diverted.
- Seasonal: MFA refresh for losses, input and fuel summaries, and outcome reporting.

Minimum data quality rules

- Use the same units everywhere (kilograms for fruit and compost, litres for fuel and water).
- Record dates and locations for every entry.
- Keep one verifiable reference for each key number (a receipt, a photo of a logbook page, or a signed tally sheet).
- Triangulate critical figures using at least two sources when possible, for example, by matching hub intake records to producer delivery sheets.

Step 8 summary

What gets measured	Why it matters
Losses, inputs, fuel, water, compost	Shows whether circularity is reducing waste and pressure on resources in measurable terms
Safety and inclusion	Demonstrates that improvements do not come at the cost of health or fairness
Income and enterprise growth	Shows whether pilots are becoming bankable and worth scaling
Participation and trust	Confirms whether collective systems can be sustained without constant external support

Step 9: Financing Strategy and Investment Mobilisation

The Opportunity Mapping Report sets out clear priority interventions, but it does not provide unit costs or a bill of quantities. For that reason, this roadmap treats financing as an agreed architecture: what needs funding first, who is best placed to fund it, and how to reduce the risk so that pilots can become investable. The financing approach also reflects the report's findings that women dominate trading but face limited access to finance and equipment, and that youth engagement is strongest through service roles rather than farming.

9.1 Priority intervention cost buckets (to be locally priced)

The cost buckets below follow the report's priority opportunities and recommendations, particularly: packhouse rehabilitation, reusable crates, composting pilots in Somanya and Nsawam, solar-drying microenterprises, farmer field schools on pesticide safety and PPE, and stronger producer-processor arrangements.

A practical way to describe costs at this stage is to separate shared infrastructure (often too large for one farmer or trader to finance alone) from enterprise equipment (which can be financed by groups or small businesses), and working capital (which is often the binding constraint for women traders).

Table 9.1: Cost buckets aligned to OM priority actions

Priority intervention	What needs paying for (cost bucket)	What drives cost most	Why it is prioritised in the OM
Drying and micro-processing hubs (solar drying, fruit leather, puree)	Dryers (solar and hybrid where needed), preparation tables, knives/slicers, hygiene equipment, packaging, basic quality assurance and storage	Dryer type and capacity; packaging and hygiene set-up; staffing and training	The report identifies decentralised processing and solar drying as key waste-valorisation opportunities and recommends solar drying micro-enterprises in the medium term.
Reusable crate system	Crate inventory, washing and hygiene set-up, simple tracking, return logistics	Number of crates required; cleaning operations; loss/damage replacement	The report recommends reusable crates to reduce mechanical damage and replace single-use packaging, and highlights packaging waste as a circularity hotspot.
Packhouse and aggregation strengthening (Ajankiti packhouse, collection centres)	Rehabilitation works, shade structures, sorting and grading tables, washable surfaces, basic storage, signage and records	Condition of the facility; utilities; minimum hygiene requirements	The report identifies the Ajankiti packhouse as inactive since 2013 and recommends rehabilitation as a multi-value chain aggregation and light-processing hub.

Composting and biofertiliser pilots (Somanya and Nsawam)	Space and site preparation, labour, turning tools, bags, basic maturity checks, optional shredders	Site availability and management; labour; contamination control	The report recommends pilot composting facilities and identifies limited nutrient cycling and high agrochemical dependence as hotspots.
Safer production package (PPE, pesticide safety, ISFM/IPM training)	PPE kits, farmer field schools, training materials suited to low literacy contexts, cooperative procurement arrangements	Number of farmers covered; procurement and replenishment	The report documents minimal PPE use and recommends short-term farmer field schools on pesticide safety and PPE.
Producer-processor linkage strengthening (outgrower/ subcontracting arrangements)	Coordination costs, quality compliance support, aggregation logistics, recordkeeping and dispute resolution	Scale of the linkage and quality requirements	The report calls for strengthened private sector collaboration, including outgrower schemes and expanded subcontracting with Blue Skies, HPW Fresh & Dry, and Bomarts.

Comparative measurement to explain the scale of the financing need (baseline signals from the OM)

- Pineapple farms in the study used 76,550 kg of synthetic fertiliser, roughly equivalent to 1,531 50-kg bags. This illustrates why compost blending and nutrient substitution can translate into meaningful cost savings over time, even before pricing is calculated.

- Mango producers recorded 148,869 kg of fruit lost or unutilised, roughly 2,980 sacks of 50 kg. Even modest investment in surplus routes can therefore protect very large volumes of value.

9.2 Funding sources (stacked finance)

The OM recommends actions that naturally point to a "stacked" approach: public and district support for shared infrastructure, partner funding for pilots, private sector co-investment where off-take exists, and accessible finance for women- and youth-led enterprises in logistics and processing.

Table 9.2: Funding sources matched to OM interventions

Funding source	Best used for	OM recommendations
Public funding and district support	Packhouse rehabilitation, collection centres, market shade and hygiene improvements, extension-led training	The OM recommends rehabilitating the Ajankiti packhouse and integrating circular indicators into district planning, suggesting a role for district-level support in enabling infrastructure and oversight.
Partner and project grants (pilot capital)	Piloting composting facilities, early equipment for drying hubs, demonstration of reusable crates, initial training packages	The OM's short-term actions include pilots and training that require initial capital before commercial revenues are proven.

Private sector co-investment (off-take linked)	Quality systems, aggregation logistics, processing-linked surplus absorption, public-private compost distribution models	The OM proposes stronger processor collaboration, outgrower schemes, and subcontracting with Blue Skies, HPW, and Bomarts, as well as public-private compost distribution linked to processors.
Community finance and working capital (VSLA, susu, cooperative credit routes)	Crate deposits, small equipment, packaging purchases, short-term working capital for women traders and hub operators	The OM highlights financial constraints faced by women traders and recommends gender-focused microfinance and low-interest financing for women and youth engaged in processing and logistics.

A key point from the OM is that finance has to match the reality of who operates where. Women dominate trading and will be central to crate systems and market handling, while youth are more likely to take on logistics and service roles. Financing products therefore, need to be designed around trading cycles and service revenues, not only farm production cycles.

9.3 De-risking mechanisms

The OM points to practical ways to reduce risk without inventing complex instruments.

- **Reduce market risk through guaranteed off-take**
  The report explicitly recommends outgrower schemes and strengthened collaboration with processors. Where processors or large buyers can guarantee demand for agreed grades, the risk of drying hubs and aggregation services falls sharply.

- **Reduce quality risk through simple standards and training**
  The report recommends training in sorting and grading, and improved post-harvest hygiene. This protects revenues by reducing rejection and reduced-price sales.

- **Reduce asset-loss risk through system design**
  Reusable crate systems work when deposits, return rules, cleaning responsibilities and simple tracking are agreed and enforced. The OM proposes deposit-return and packaging banks as part of the solution set.

- **Reduce adoption risk through affordable finance**
  The OM's recommendation for gender-focused microfinance and low-interest financing is itself a de-risking tool, as it improves women traders' and youth operators' ability to adopt and sustain new practices and assets.

Table 9.3: Key risks and OM-aligned mitigations

Risk to investment	What it looks like on the ground	OM-aligned mitigation
Demand risk for new products	Hubs produce dried fruit but struggle to sell consistently	Off-taker agreements and subcontracting models with processors; clear market routes for products
Quality and rejection risk	Fruit rejected at aggregation due to bruising or poor grading	Training on sorting, grading and hygiene; packhouse and collection centre upgrades
Working capital constraints	Women traders cannot afford crates, packaging, or hub input purchases	Gender-focused microfinance and low-interest financing for women and youth businesses
Safety and compliance risk	Low PPE use increases health risks and reputational risk	Farmer field schools on pesticide safety and PPE; cooperative procurement approaches
Coordination risk	Fragmented actors and weak cooperation undermine shared systems	Support for farmer-based organisations; strengthened institutional linkages and district integration

9.4 Investment instruments

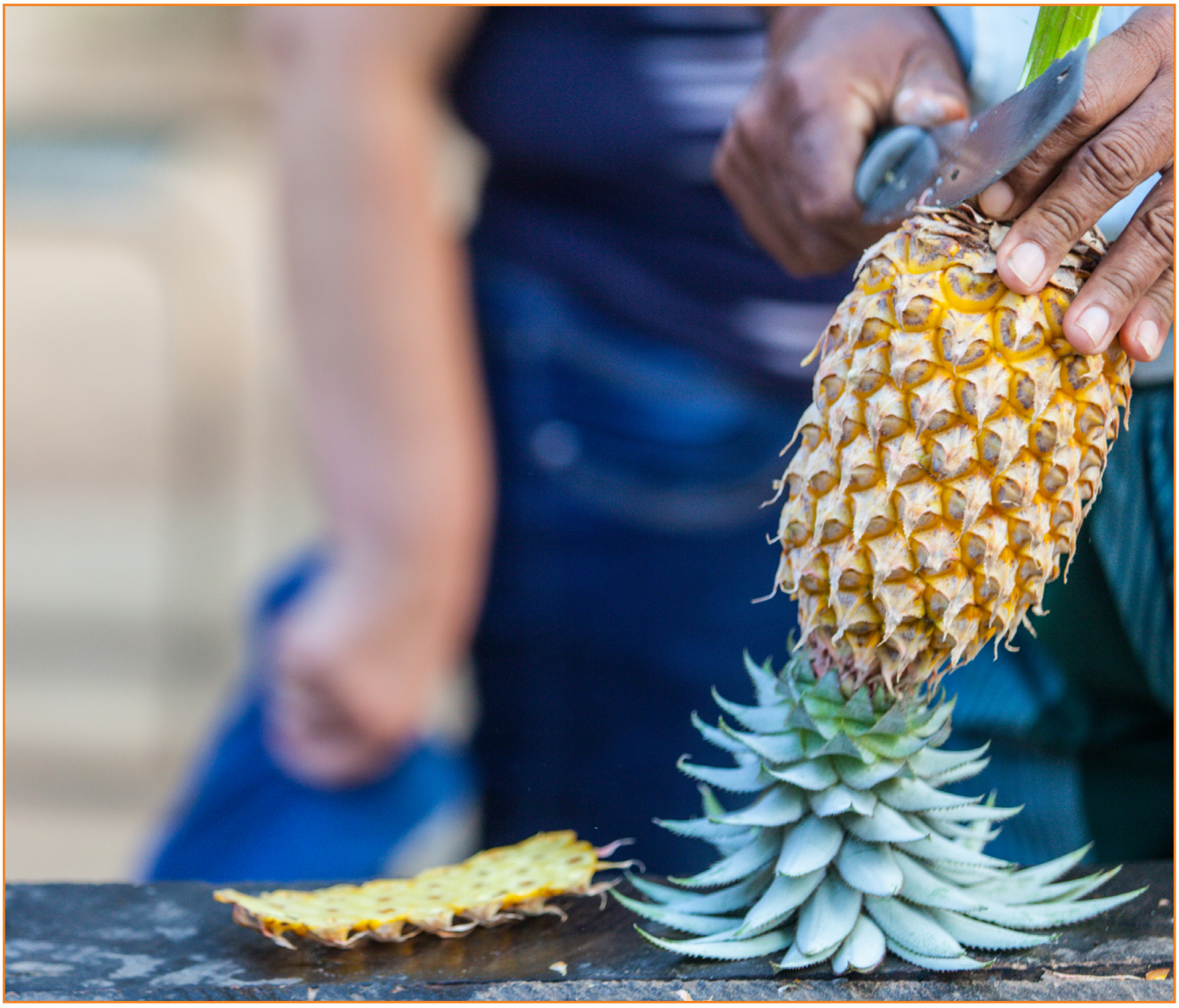
To mobilise finance without inventing numbers that are not in the OM, investment instruments should focus on documenting and packaging the OM-recommended interventions into fundable components.

- **Pilot-ready business cases (one per pilot model)**
  These would set out the operational design, ownership structure (for example women-led cooperatives), the off-take route, and the MRV indicators. They translate the OM's opportunity areas into fundable pilots.
- **Finance packages for women and youth enterprises**
  The OM recommends gender-focused microfinance and low-interest financing for women and youth engaged in processing and logistics; these packages should be co-designed with local finance providers and linked to specific asset needs such as crates, dryers and logistics services.

- **Public-private agreements**
  The OM proposes public-private compost distribution models linked to processors and stronger processor collaboration; written agreements make these arrangements investable and easier to scale.

Step 9 summary

Financing focus	What gets funded	Why it matters (OM logic)
Shared infrastructure first	Packhouse rehabilitation, collection centres, compost sites	Tackles the infrastructure and coordination bottlenecks linked to losses and waste
Enterprise equipment and working capital	Drying hubs, crates, packaging, logistics services	Turns waste and handling improvements into income opportunities, especially for women and youth
Safety and skills as investable foundations	PPE, pesticide safety, sorting and grading training	Addresses the OM-identified safety gap and supports quality and market access
Off-take linked finance	Outgrower and subcontracting models with processors	Reduces demand risk and makes pilots easier to scale



Step 10: Capacity Development and Institutional Strengthening

10.1 Modular training (low-literacy friendly)

The Opportunity Mapping Report shows that education levels are modest across the value chain, particularly among women traders, and that this affects recordkeeping, uptake of improved practices, access to finance, and engagement with certification requirements. In the mango chain, over 62% of female traders and 59% of female producers had only basic education or no formal education. A similar pattern is reported for pineapple women traders, with most having primary or junior high school education. Training therefore, needs to be practical, demonstration-led, and built around short modules that can be repeated and reinforced through routine market and farm visits.

Training modules should directly reflect the short- and medium-term recommendations in the report, including sorting, grading and post-harvest hygiene; solar drying and low-cost processing technologies; and farmer field schools on pesticide safety and PPE.

Table 10.1: Modular training package, by actor group

Actor group	Training modules (priority)	What "good practice" looks like	Practical outputs to verify uptake
Producers	Harvest handling and farmgate sorting; basic grading; safe spraying and pesticide safety; PPE use; compost use and compost blending; integrated soil fertility management and practical IPM	Less bruising at farmgate; clear separation of grades; PPE used during spraying; safer storage and disposal of agrochemical containers; compost applied with basic guidance	Farm log sheets for harvest and rejects; simple PPE compliance checks; input records showing reduced dependency where blending trials are used
Traders and market actors	Sorting and grading at market; crate hygiene and handling; shade handling; simple recordkeeping; basic waste segregation for residues	Reduced spoilage and fewer "reduced-price" sales from damage; reusable crates managed and returned; cleaner handling spaces; residues separated for collection	Trader cycle logs (full price, reduced price, discards); crate bank return records; market cleanliness and waste separation checks
Processors and SMEs	Quality assurance basics; food safety basics; packaging and storage; costing and simple business planning; product specifications for dried fruit and pulp	Consistent product quality; traceable batches; basic hygiene controls; packaging that protects quality and reduces waste	Batch records; rejection logs with reasons; simple cost sheets and sales records

This training focus is consistent with the report's recommended actions: training farmers and traders in sorting, grading, and improved post-harvest hygiene; introducing solar-drying microenterprises; and delivering skills training in solar drying, juice extraction, and low-cost processing technologies.

Delivery approach

To match the constraints identified in the report, each module should be delivered through a mix of:

- short practical demonstrations at farms, aggregation points and markets
- "learning by doing" sessions tied to the pilots (drying hubs, crate banks, compost sites)
- low-text visual job aids (for example pictures showing grading classes, crate loading, compost maturity checks, and PPE steps)

This approach is justified by the report's emphasis on the constraints posed by low literacy and the need for skills training suited to low-literacy environments.

Comparative measurement to support behaviour change

Two examples that help training feel real:

- The report records zero use of PPE among surveyed mango farmers, despite widespread insecticide and herbicide use. In practical terms, "zero" means that no one in the study sample reported using PPE at all. This makes PPE training a priority because the change is clear and observable.

- The pineapple chain applies 76,550 kg of chemical fertiliser, roughly 1,531 50-kg bags. Compost blending training can use this comparison to show what "10% replacement" or "20% replacement" means in everyday terms.

10.2 Extension officer upskilling

The report identifies weak extension support as a constraint, particularly limited training on composting and organic alternatives. Strengthening extension capability is therefore a core part of institutional strengthening, because farmers and traders will need consistent, trusted advice as pilots move to scale.

Extension upskilling should focus on two practical areas that reflect the report's priority opportunities.

- **Compost maturity and compost blending guidance**
  Extension teams should be able to support basic compost quality checks and advise on safe use, including how to blend compost with synthetic fertiliser for fruit crops. This aligns with the report's recommendations on micro-composting units, organic-chemical blends, and training in integrated soil fertility management.

- **Practical IPM alternatives and safe chemical stewardship**
  The report documents heavy pesticide use and serious health risks where PPE is not used. Extension teams therefore need the capability to deliver farmer field schools on pesticide safety and PPE, and to promote practical IPM alternatives that reduce reliance on chemical controls over time.

Table 10.2: Extension upskilling priorities and what they enable

Upskilling area	Why it is needed (from OM)	What it enables in the roadmap
Compost maturity and blending	Minimal uptake of organic alternatives; limited nutrient cycling; weak extension support on composting	Compost pilots that produce usable product; credible blending trials; reduced chemical dependency over time
IPM and safe chemical stewardship	High pesticide volumes and zero PPE use reported; occupational health risks	Farmer field schools that change practice; safer spraying; stronger compliance with buyer expectations

10.3 Vocational partnerships

The report recommends enterprise pathways, such as solar-drying microenterprises, women-led processing cooperatives, and youth-focused business models in logistics and waste collection. To make these work at scale, the roadmap needs short, practical vocational courses that build competence for specific roles, rather than one-off awareness training.

Priority short courses should include:

- **Dryer operators:** safe preparation, drying control, hygiene, packaging and simple quality checks for dried fruit products.
- **Compost supervisors:** feedstock handling, contamination control, turning routines, maturity checks, bagging and basic recordkeeping.
- **Crate bank managers:** inventory control, hygiene routines, deposit-return rules, and basic tracking and reporting.

These roles align with the report's focus on developing skills in solar drying and low-cost processing technologies, scaling composting units, and deploying reusable crate programmes supported by workable systems.

A key inclusion point from the report is that youth are more visible in trading and transport services than in farming. Vocational courses should therefore be designed so that youth can enter the value chain through logistics, crate return systems, and waste aggregation services, with a clear route to income.

10.4 Institutional integration

The Opportunity Mapping Report recommends integrating circular economy indicators into district agricultural planning and monitoring frameworks. Institutional integration is therefore about ensuring that MRV is not a stand-alone project activity but is part of routine district reporting and value chain coordination.

In practice, this means:

- agreeing a small set of indicators that district teams can maintain (loss rates, compost produced, crate circulation, PPE adoption in producer groups)
- using district review meetings to discuss results and adjust actions
- linking farmer-based organisations to district plans so that bulk purchasing, aggregation, and shared asset management are recognised delivery mechanisms

This also supports the report's recommendation to strengthen institutional linkages and private sector collaboration, including support for farmer-based organisations and structured relationships with processors and off-takers.

Table 10.3: Institutional strengthening actions linked to OM recommendations

Institutional action	What it changes	OM link
Embed CE indicators into district agricultural planning	Makes progress visible and accountable; supports scale beyond pilots	Explicit recommendation in long-term actions
Strengthen FBO capability for bulk purchasing and shared assets	Improves coordination for crates, composting sites and aggregation systems	Recommended as part of stronger institutional linkages
Align training and standards with processor requirements	Reduces rejection and stabilises demand	Linked to strengthening private sector collaboration and subcontracting

Step 11: Governance and Integration Framework

11.1 Multi-level governance (simple, real)

The Opportunity Mapping Report describes fragmented coordination across both value chains, with cooperatives that exist but are underutilised and weakly coordinated in some areas. It also recommends strengthening institutional linkages and private-sector collaboration, including support for farmer-based organisations, stronger off-taker arrangements, and the integration of circularity metrics into district agricultural planning.

Given how the chains operate in practice, governance needs to be light-touch and grounded in day-to-day decision points: where fruit is graded, moved, and losses and residues are managed. The minimum governance structure is therefore built around districts and the main market and aggregation nodes.

District steering group (district-level oversight and coordination)

Each corridor should have a district steering group, anchored by the district assembly and extension services, with representatives from market leadership and farmer-based organisations included. The steering group's role is to remove bottlenecks that local actors cannot solve alone, such as access to market space for shade handling, basic packhouse functionality, and alignment of extension support with pilot needs.

Value chain working group (delivery group across actors)

A corridor-level working group should bring together producers, traders, aggregators, transporters, processors and youth representatives. This group focuses on practical operating rules and delivery sequencing, including grading routines, crate deposit rules, residue collection routes, and what happens to surplus fruit during peak season. The need for this group is reinforced by the report's finding that surplus mango and pineapple are not consistently absorbed by buying companies, and that stronger producer-processor arrangements are required.

Pilot management units (one per pilot, with transparent tracking)

Each pilot needs a small management unit responsible for day-to-day delivery, simple reporting, and corrective action. The pilot management unit is also the most practical place to host "transparent dashboards" because it holds operational data, including hub intake and output, crate movements, compost batches, and basic safety checks. The report's emphasis on trust-building and feedback makes this transparency a delivery requirement, not a communications extra.

Table 11.1: Governance structure and core responsibilities

Governance layer	Who is involved	What decisions it owns	What it produces
District steering group	District assembly, extension services, market leadership, FBO representatives	Corridor priorities, enabling infrastructure, integration into district planning, enforcement of basic market hygiene rules	Annual corridor plan, agreed indicators, decisions on shared assets and market space
Value chain working group	Producers, traders, aggregators, transporters, processors and youth representatives	Practical operating rules, coordination of collection and aggregation, surplus routing, linkages with off-takers	Operating rules, MOUs where needed, shared delivery calendar
Pilot management unit	Pilot operators and nominated representatives from user groups	Day-to-day operations, recordkeeping, corrective action, reporting	Pilot logs, monthly progress summaries, public results notices

Comparative baseline signals that justify "simple but firm" governance

The study itself engaged 300 actors across the two value chains (81 mango producers, 38 mango traders, 130 pineapple producers, 51 pineapple traders). That scale of participation illustrates why delivery structures must be simple and repeatable rather than rely on ad hoc coordination.

In addition, the report documents 25% mango and 10% pineapple losses across farm and market nodes, and a safety baseline where PPE use is effectively absent during spraying. These are outcomes that require coordinated action, not isolated projects.

11.2 Integration into planning

The report recommends integrating circular economy indicators into district agricultural planning and monitoring frameworks, and strengthening institutional linkages so that pilots can become sustained practice.

Integration should follow a straightforward annual cycle built around the fruit seasons.

- **Annual target setting (pre-season):** districts and working groups agree corridor targets using the most recent MFA and environmental baselines, and confirm which pilots will expand and where.
- **In-season delivery review (peak season):** a short mid-season review focuses on operational performance: losses, crate returns, surplus handling, compost production, and safety compliance.
- **Post-season review:** districts and working groups review results against agreed indicators, identify what worked, and lock in next season's improvements.

This planning approach ensures that MRV is not a separate exercise, but part of how district teams manage performance and allocate support.

11.3 Oversight principles

Oversight needs to respond directly to the social conditions described in the report. Fieldwork revealed widespread frustration linked to years of engagement without feedback or tangible benefits, with survey fatigue and scepticism explicitly reported in Somanya and surrounding communities. The report notes that mistrust reduces the willingness to adopt innovations and participate in training, especially when models require collective action.

Oversight principles should therefore include:

- **Transparency by default:** publish simple results back to communities and markets, using plain numbers that match daily experience (for example sacks of fruit handled, crates in circulation, bags of compost produced).

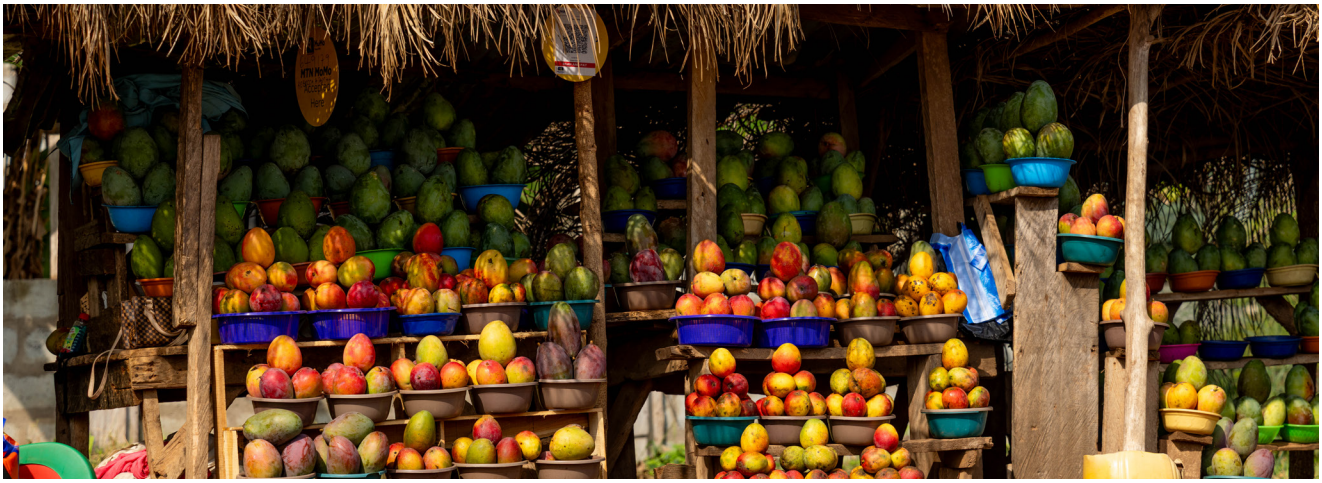
- **Shared accountability:** each stakeholder group has named responsibilities, not just "general participation".

- **Inclusion in decision-making:** women traders and youth service operators are included in decision-making processes because they are key delivery actors in packaging, logistics, and waste recovery.

- **Safety and integrity:** zero tolerance for unsafe spraying norms, given the baseline of heavy agrochemical use with no PPE protection.

Step 11 summary table

Component	Purpose	Proof of success
District steering group	direction, enabling conditions, integration into district plans	annual plan agreed; shared assets and space decisions delivered
Value chain working group	practical coordination across actors	operating rules in place; off-taker linkages functioning
Pilot management units	delivery and reporting	regular logs, corrective actions taken, results published locally



Step 12: Communications, Behavioural Change and Cultural Shifts

12.1 Storytelling and recognition

The Opportunity Mapping Report makes clear that circular interventions will not succeed through technical measures alone. Trust is fragile in some communities, and adoption is affected by whether people can see results and believe that participation is worthwhile. Communications therefore needs to do two things: make change visible, and recognise the people who are doing the work.

A practical approach is to frame messages around a small number of outcomes that are already evidenced in the report and easy to understand:

- Mango losses are high across farm and market nodes, equivalent to roughly one quarter of fruit not reaching consumers.
- Pineapple losses are lower but still significant, and the chain is highly dependent on synthetic fertilisers and pesticides.
- PPE use during spraying is effectively absent in the baseline, creating serious health risks.

Recognition should be designed to reinforce the behaviours the roadmap needs, such as safer spraying, better handling, and participation in shared systems like crate banks and composting sites.

Examples of recognition mechanisms that fit the roadmap:

- "Loss rescued" reporting by community or market, expressed in simple measures such as sacks of 50 kg or crates handled, alongside kilograms where needed.
- Awards linked to safety and enterprise, such as consistent PPE use in producer groups, or women-led enterprises that meet basic hygiene and recordkeeping requirements.

They are intended to normalise new practices and maintain high participation across seasons, especially given the report's highlights of mistrust and survey fatigue.

12.2 Local language and low-literacy messaging

The report documents low educational attainment among value chain actors, particularly among women traders, and concludes that circular interventions must include training suited to low-literacy environments.

Communications materials should therefore be visual and practical, not text-heavy. Priority formats include:

- Radio segments in local languages during peak seasons, focused on handling routines, safety, and where to take surplus fruit.
- Posters and pictorial standard operating procedures in markets, aggregation points and pilot sites, covering:
  - ◊ PPE steps for spraying
  - ◊ sorting and grading cues
  - ◊ drying hygiene
  - ◊ crate return rules and hygiene routines
  - ◊ residue separation for composting

The core principle is that someone should be able to understand the message at a glance, and then see it demonstrated in practice through pilots and extension support.

12.3 Community-led channels

The report notes that trust-building is essential, and that women traders are key entry points for packaging, sorting and waste recovery systems. It also notes that youth involvement is more visible in trading and transport services, making youth well-suited to logistics and service-based circular roles.

Community-led channels should therefore focus on peer credibility:

- **Peer champions:** trusted traders and respected farmers act as trainers and champions for specific practices, such as crate handling, sorting routines, or safe spraying behaviours.
- **Open demonstration days:** short, practical events that allow people to see and test the changes, such as tasting dried products from hubs or visiting compost trial plots to see the difference between mature compost and unfinished material.

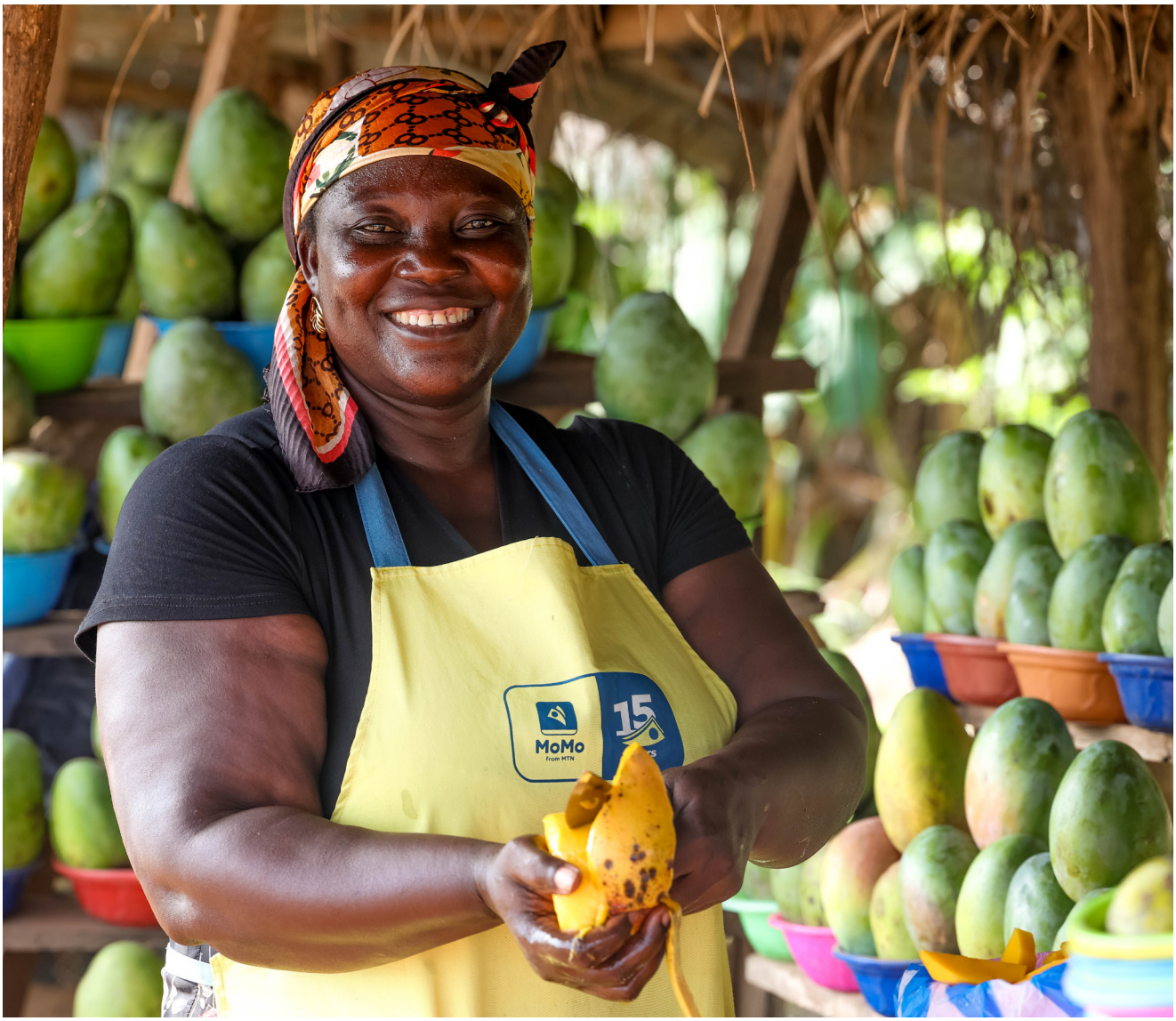
This approach reduces reliance on one-off workshops and replaces them with repeated, local reinforcement, which aligns with the report's guidance on low literacy and the need for consistent engagement.

Table 12.1: Communications focus and the behaviour it is intended to change

Communications focus	Behaviour change goal	How success is evidenced
Loss reduction and surplus routing	more fruit goes through grading and surplus routes rather than being discarded	higher hub intake; lower reported unutilised fruit
Safety messages	PPE becomes normal practice during spraying	observed PPE use during spot checks; farmer field school coverage
Packaging and handling messages	crates and shade handling become routine where systems exist	higher crate circulation and return rates; reduced spoilage and markdowns
Inclusion messages	women and youth see clear roles and pathways	increased participation in cooperatives, hubs and service roles
Trust and feedback	people see results and stay engaged	repeat participation and reduced resistance to collective models

Step 12 summary table

Element	Purpose	Proof of success
Storytelling and recognition	make progress visible and valued	participation sustained across seasons; practical uptake improves
Local language and visual messaging	make training accessible	SOPs used on site; fewer handling and hygiene failures
Community-led channels	build trust and normalise new practice	peer champions active; demonstration days draw repeat attendance



Step 13: Circular Business Model Incubation and Scaling

13.1 Business models identified (ready to incubate)

The Opportunity Mapping Report highlights high-potential circular opportunities that lend themselves to simple, replicable business models. These models are designed to do three things at once: reduce losses and waste, reduce harmful exposure and input dependence, and create realistic income pathways for women and young people, reflecting the report's gender and youth findings.

Table 13.1: Priority business models for incubation

Business model	Typology	Problem addressed (baseline signal)	Core opportunity (as described in the OM)
Surplus-to-snack hub (solar drying, fruit leather, puree where feasible)	Circular value addition	High on-farm mango losses, including 148,869 kg left unutilised at producer level (18.8% of harvest in the sample)	Solar drying, puree production, fruit leather, decentralised processing; new products and women and youth employment
Crates-as-a-service (crate bank, deposit-return, cleaning and tracking)	Product-as-a-service	Trader-level spoilage and heavy reliance on single-use polybags, sacks and boxes	Reusable crates, community packaging banks and deposit-return systems to reduce mechanical damage and packaging waste
Compost-to-farm blending (community composting plus distribution)	Resource recovery	Limited nutrient cycling and high agrochemical dependence, including 76,550 kg fertiliser in pineapple and minimal uptake of organic alternatives	Scaling community composting units; public-private compost distribution linked to processors; piloting organic-chemical fertiliser blends for fruit crops
Safety-to-soil package (PPE, safe spraying, IPM, ISFM, compost blending)	Risk reduction and productivity	Low PPE use and chemical exposure, alongside heavy insecticide and herbicide use	PPE provision models, cooperative procurement, farmer field schools on pesticide safety and eco-input training; integrated pest management and soil fertility management

Where suitable, these models can be linked to longer-term opportunities noted in the report, such as animal feed formulation from peels and pulp residues, or industrial symbiosis approaches for residues and energy, building on examples such as HPW Fresh & Dry's near-zero-waste system.

13.2 Projected returns

The OM provides strong evidence on physical quantities and hotspots, but it does not provide market prices, operating costs, or unit economics. The projections below therefore, show the physical logic of value creation, using OM baselines and clearly stated assumptions that should be validated through pilots.

Surplus-to-snack hub (mango-first, pineapple-compatible)

- The OM quantifies 148,869 kg of mango left unutilised at producer level in the survey sample. In everyday terms, that is about 149 tonnes, or roughly 2,980 sacks of 50 kg.
- If half of this volume is captured for processing in pilot areas, that is about 74,000 kg of fresh fruit redirected from waste to product. This is about 1,480 sacks of 50 kg.
- Drying yields depend on moisture content and product specification. A common working assumption for fresh-to-dried mass is 15% to 25% (to be confirmed locally). On that basis:
  - ◊ 74,000 kg fresh could produce roughly 11,000 to 19,000 kg dried output.
  - ◊ That is roughly 220 to 380 sacks of 50 kg of dried product.

- The main economic value comes from converting "processing grade" fruit that would have been wasted into a stable product with a longer shelf life, which can be sold outside the immediate peak season.

Crates-as-a-service

- The OM reports trader-level discard of 2.05% per mango trading cycle and 1.9% pineapple discard per 1,000 kg handled, alongside widespread use of sacks and polybags that increase mechanical damage.

- If improved handling and reusable crates contribute to halving market-level losses where implemented (the OM notes that infrastructure measures can reduce market-level losses by up to 50%), the practical gain is simple: for every 1,000 kg handled, up to about 10 kg of fruit could shift from "discarded" into "sold", depending on local conditions and full package adoption.

- The service earns its return through rotation: deposits, service fees (where used), and reduced replacement costs when return rates are high and cleaning routines are consistent.

Compost-to-farm blending

- The OM records 76,550 kg of fertiliser use in pineapple in the sample, with very low organic input use. 76,550 kg is roughly 1,531 bags of 50 kg.

- The physical logic of return is that compost and blended inputs reduce reliance on synthetic inputs and improve soil condition over time. A 10% reduction in synthetic fertiliser use within a pilot group is about 7,655 kg, or 153 50-kg bags. A 20% reduction is about 306 bags.

- Compost output depends on feedstock mix, moisture, and process losses, so pilots should measure actual yields and contamination rates and then set realistic supply targets.

Safety-to-soil package

- The OM identifies low PPE use and high chemical volumes as a serious risk, and recommends farmer field schools on pesticide safety and PPE, alongside integrated management practices.

- The "return" here is both economic and social: fewer health incidents and lost workdays, improved compliance with buyer expectations, and stronger readiness to scale residue recovery and value addition safely.

13.3 Readiness pillars and support needs

Incubation should focus on the enabling conditions the OM itself highlights: skills suited to low levels of formal education, access to finance for women- and youth-owned enterprises, basic infrastructure for grading and handling, and stronger linkages with processors and off-takers.

Table 13.3: Readiness pillars and support needs

Pillar	Support needs (aligned to OM recommendations)
Technical	Dryers and low-cost processing technologies; drying and hygiene routines; compost maturity practices; sorting, grading and handling protocols; crate hygiene and return routines
Financial	Gender-focused microfinance for women traders and women farmers; low-interest financing for women and youth engaged in processing and logistics; working capital for seasonal procurement and packaging
Policy and regulatory	Practical food safety guidance for community processors; permissions and space allocation for market-based collection centres, shade structures and crate banks; district support for packhouse reactivation and monitoring
Market development	Off-taker arrangements and subcontracting models with processors such as HPW, Blue Skies and Bomarts; agreed quality specifications; clearer pathways for surplus absorption during peak periods
Institutional coordination	Support for farmer-based organisations to bulk purchase and coordinate marketing; integration of circularity metrics into district agricultural planning; a coordination platform as models scale

13.4 Incubation mechanisms

The OM emphasises that many actors have modest educational backgrounds and that market support programmes, including business skills and financial literacy, must be accessible to women and people with limited formal education.

The incubation mechanism therefore prioritises practical delivery over paperwork-heavy approaches.

A workable incubation package includes:

- Pre-incubation training linked to pilots, covering sorting, grading and post-harvest hygiene, solar drying and low-cost processing skills, compost production

and safe handling, and basic recordkeeping.

- Business and finance readiness support, focused on simple cash records, stock control, and the requirements of microfinance and low-interest financing products aimed at women and youth.

- Shared infrastructure and shared services, using packhouse and collection centres as common points for grading, aggregation, residue collection, and where feasible, light processing support.

- Market linkage clinics, bringing incubated enterprises together with processors and off-takers to agree specifications and procurement routes, including subcontracting and outgrower arrangements where appropriate.

These mechanisms are designed to convert OM recommendations into practical routes to bankable operations without assuming costs or prices that the OM does not provide.

13.5 Scaling path

The OM sets out short-, medium-, and long-term recommendations, including solar-drying microenterprises (1 to 3 years), access to low-interest finance for women and youth, expanded collection centres, and strengthened private-sector collaboration, with longer-term ambitions for export-oriented circular processing and a national coordination platform.

Table 13.5: Scaling pathway

Phase	Timeline	Key outputs (consistent with OM direction)
Proof of concept	Years 1 to 2	Pilot enterprises operating consistently; basic quality routines in place; evidence of volumes rescued or diverted; early MRV sufficient to show performance and safety uptake
Partnerships	Years 2 to 3	Off-taker agreements and subcontracting pathways strengthened; low-interest finance and microfinance products activated for women- and youth-owned enterprises; expanded collection centres and improvements to market handling.
Replication	Years 3 to 4	District-to-district replication of the most robust models; circular indicators embedded in district monitoring; clearer coordination across actors in line with the report's call for stronger institutional linkages

In practice, replication should follow the OM's emphasis on strengthening coordination and market linkages. The models that scale best are likely to be those that can show three things clearly: reliable volumes, acceptable quality, and a stable buyer route, alongside simple governance that keeps shared systems like crate banks and compost sites working across seasons.

In partnership with Canada

Ghana Circular Economy Centre

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION

Republic of Ghana

About Ghana Circular Economy Centre

The Ghana Circular Economy Centre (GCEC) project supports Ghana's transition to a resource-efficient and inclusive circular economy by promoting innovation, strengthening policy and institutional frameworks, and building capacity across key value chains, including plastics, agriculture and agro-processing (cassava, mango, pineapple and tilapia), and textiles.

The project is implemented by the United Nations Industrial Development Organization (UNIDO) in partnership with the Ministry of Environment, Science and Technology (MEST), with funding support from Global Affairs Canada.

The GCEC serves as a national hub for knowledge generation, stakeholder engagement, and the piloting of circular solutions to advance sustainable industrial development, improve resource efficiency, and create decent jobs.

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