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Climate-resilient Solution Packages Compendium

Enabling Sustainable Agriculture systems for last-mile communities



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Common Structure of Solution Packages

The solution packages generally cover the following topics:

1. Overview and Need
2. Services Offered
3. Technologies and Equipment
4. Business Models and Investment Costs
5. Case Studies and Field Experiences
6. Replication Potential and Suitability
7. Scheme Convergence and Government Support

Introduction

Small and marginal farmers constitute nearly **89% of India's operational landholdings** yet cultivate less than half of the country's agricultural land, making them particularly vulnerable to climate and market shocks. While the Green Revolution significantly improved food production, it also contributed to the overuse of chemical inputs, groundwater depletion, and declining soil health. Climate change has further intensified these challenges through erratic rainfall, droughts, heat stress, and pest outbreaks. Inadequate access to storage, drying and processing facilities near farms further contributes to post-harvest losses and forces farmers to sell their produce at lower prices.

Sustainable and climate-resilient agriculture is essential to restore natural resources, improve productivity, strengthen resilience, and enhance farmer incomes. Across the agricultural value chain, solution packages have emerged that combine sustainable practices with appropriate technologies—from soil health management and bio-input preparation to efficient irrigation, climate-smart cultivation, post-harvest storage, decentralized processing, and value addition.

These include solar dryers and cold storage units, small-scale processing machinery, on farm solutions, field sensors and decentralised bio-input production units. However, identifying the right solution for different end users and accessing affordable financing for these remains a challenge. Farmers and implementing organisations need clear information on technology suitability for specific agricultural practices, investment requirements, ownership and operational models, potential revenue streams and available financial support.

This compendium brings together nine solution packages covering key stages of the agricultural value chain, from input production and farm-level practices to post-harvest management and value addition. Packages 1–3 focus on strengthening access to and production of agricultural inputs, Packages 4–6 address farm-level production practices, while Packages 7–9 focus on reducing post-harvest losses, improving processing and creating value-addition opportunities.

A key focus of this compendium is to demonstrate how these decentralized solutions, combined with package of practices and appropriate financing can be owned and operated by individual small and marginal farmers, women’s groups and Farmer

collectives to make agriculture more resilient, productive and sustainable for these last-mile communities.

The compendium is intended to serve as a practical reference for:

- **Individual Farmers, Women entrepreneurs and Farmer collectives:** To understand available solutions, their applications, investment requirements and potential benefits
- **Field practitioners, NGOs and Community organizations:** Including Krishi Sakhis, extension workers and agri-entrepreneurs, to identify and recommend suitable solutions based on local needs and end-user capacities, determine appropriate ownership and business models for on-ground adoption
- **Financiers and Government agencies:** To strengthen understanding of the relevance of these solutions for end-users, the financial and business models through which they operate, and the opportunities for convergence with existing financial products and schemes. To ensure consistency and ease of reference, each solution package follows a standardised structure covering the need and agricultural practice, technology details, business models and costs, field-level case studies, replication potential and suitability for end-user groups, and relevant government schemes. The cost estimates, equipment specifications and financial returns presented in this compendium are based on field-level experiences and supplier information. These may vary depending on the crop, geographical location, scale of operation and local market conditions. It would be important to validate the technical and financial details locally before making specific investment decisions.

Overall, this compendium aims to bridge the gap between sustainable agricultural practices, available decentralised technologies to enable these practices, and their adoption on the ground by providing practical guidance on solution selection, ownership, implementation, financial viability and replication across agricultural value chains.

Solution package list

This compendium brings together nine solution packages. Together, they cover three stages of the farming value chain.

- Packages 1 to 3 strengthen the supply of farm inputs,
- Packages 4 to 6 improve production on the farm, and
- Packages 7 to 9 help farmers reduce losses after harvest and earn more through value addition.

The table below provides a quick view of all nine packages.

TABLE 0.1

The nine solution packages at a glance

Let's use this representation instead of the table- in the DESIGN

Input/ Pre-production	On-farm/ Production	Post harvest & value addition
1 **Soil testing centers** run by FPOs/ individual entrepreneurs/ Agri Depts to improve information access enabling better soil health and nutrient management	**4** **On-farm practices and Zero tillage farming** with Multipurpose Toolbar/mechanization for Regenerative Agriculture techniques	**7** **Post-harvest loss management** through FPO and Aggregator-run Grading centers/ Pack-houses/Cold storage units/ Dryers for horticulture farmers to safeguard against heat stress and avoiding food losses
2 **Sustainable Seed Banks** operated by Community institutions for preservation of Indigenous seed varieties	**5** **IoT based precision farming and weather stations** for Horticulture commodities in dry and arid regions	**8** **Sustainable decentralized processing units** to increase value capture for farmers on horticulture commodities in dry and arid regions
3 **Bio-Resource Centers** to improve access to natural fertilizers, sustainable agricultural inputs for small and marginal farmers	**6** **Bio-input and vermicompost preparation and application** to improve soil nutrition and health for horticulture	**9** **SHG/FPO value addition and snack making businesses** to improve incomes and avoid food losses

PACKAGE 1

Community Seed Banks

Community Seed Banks (CSBs) are run by community institutions. They conserve and multiply indigenous and locally adapted seeds. This lowers seed costs for farmers, reduces their dependence on commercial seed suppliers and helps them build resilience to climate change.

1.1 Overview and need

A CSB is a seed bank managed by the local community. It collects, conserves, stores and distributes seeds, especially indigenous, traditional and locally adapted varieties. Its aims are to preserve these varieties, give farmers control over their own seed (seed sovereignty), increase the participation of women and marginalised groups, and promote local seed enterprises through farmer clusters. The table below shows how a community seed bank contributes.

TABLE 1.1

Contribution of community seed banks

Contribution	Role of a community seed bank
Biodiversity	Preserves indigenous varieties and genetic diversity
Farmer empowerment	Promotes seed sovereignty; reduces dependence on commercial seed
Economic sustainability	Lowers seed-input costs; supports local seed livelihoods
Climate resilience	Locally adapted, diverse crops reduce risk from drought, floods and pests
Food security and nutrition	Improves seed access; conserves traditional, nutrient-rich crops



Figure 1.1 — Seed storage at a community seed bank



Figure 1.2 — Rice Diversity Centre, Kirugavalu, Mandya

Each stage of the seed value chain affects how well seeds germinate, how pure they are, how long they can be stored and how easily farmers can get them. The table below lists the activities and quality points at each stage, along with the problem areas that show where support is needed.

TABLE 1.2

Seed value chain: activities, quality considerations and problem areas

Stage	Main activities	Quality considerations	Problem area
Production	Cultivating seed crops; field management	Seed standards, isolation, rouging, crop health, varietal purity	Labour-intensive operations; purity and climate resilience
Extraction	Separating seed from harvested crop	Crop-specific wet or dry extraction; avoiding seed damage	Crop-specific separation; post-harvest sanitation
Processing	Cleaning, drying, grading	Removing impurities; safe moisture reduction; uniform grading	Better cleaning, drying and grading
Seed coating	Applying materials to seed surfaces	Uniform coverage; approved materials	Uniform application methods
Conservation and storage	Storing seed under suitable conditions	Moisture and temperature control; pest protection; monitoring	Controlling storage moisture and temperature

Stage	Main activities	Quality considerations	Problem area
Germination testing	Testing viability before distribution	Reliable tests; documented results	Verifying viability before distribution
Packaging and marketing	Packing, labelling, branding, buyer links	Moisture-safe packs; accurate weight; clear labels	Branding and stronger buyer linkages

1.2 Services offered

The main services of a community seed bank and what each one does are listed below.

TABLE 1.3

How community seed banks operate

Service	Key function
Seed collection	Gather traditional varieties from local farmers
Selection and cleaning	Remove damaged seed; select quality planting material
Drying and storage	Maintain suitable moisture and storage conditions
Documentation	Record variety names, origin, traits and quantities
Seed multiplication	Cultivate and replenish seed stocks
Seed lending and exchange	Distribute seed; receive returns after harvest
Germination testing	Check viability before distribution
Seed kits and sales	Navadhanya Kit of nine varieties, free to selected farmers and sold to others
Knowledge and training	Diversity museums and farmer and student training

1.3 Technologies

Community seed banks use simple machines at each stage, from the field to storage and processing. The equipment is summarised below, followed by details of each machine.

TABLE 1.4

Seed bank technologies

Stage	Technologies	Purpose	Key specification
Production	Electric weeder	Reduces crop–weed competition	48 V, 1,000 W; single row; 1 acre per 2 hours
Production	Electric reaper	Cuts and collects mature crop	48 V, 2 kW; 1 acre per 2 hours
Extraction	Thresher (multi-crop)	Separates grain from straw, husk and chaff	2 HP; 100 kg/hour
Processing	Pre-cleaner	Removes dust, mud, stones, straw and chaff	85 kg/hour
Processing	Aspirator, air-screen cleaner, gravity separator	Remove chaff, dust and light material	Options; not specified
Drying	Solar dryer; batch or low-temperature forced-air dryers	Safe moisture reduction before storage	Solar dryers 75 kg to 4 tonnes
Storage	Solar-powered refrigerator or cold storage	Temperature-controlled seed storage	183 litres
Processing	Solar millet processing unit	Dehulls, grades and destones millet	20 × 335 Wp panels; 20 × 120 Ah batteries

The field cases show two ways of running a community seed bank. In both models, the seed bank conserves seeds and also earns money by selling seed and produce.

TABLE 1.5

Business models observed in the field

Model	Operator	Revenue streams
SHG-run community seed bank	SHG with a network of seed-producing farmers	Seed kit sales; seed lending and exchange; processing services; institutional seed purchases
Champion farmers with FPO multiplication	Individual conservation farmer linked to an FPC and NABARD	Direct rice sales; bulk seed multiplication through FPOs

1.5 Case studies

Syed Ghani Khan, paddy seed saviour, Kirugavalu, Malavalli taluk, Mandya.

A graduate farmer with 25 years of farming experience and recipient of the Krishi Panditha Award (2008), he initiated paddy seed conservation in 1996 with just three varieties. He maintains varietal purity through an 8–10-day flowering interval and staggered crop durations. The harvested seeds undergo pre-cleaning and 3–4 days of sun-drying to achieve 14–15% moisture content.

TABLE 1.6

Case study: Syed Ghani Khan, Mandya

Dimension	Details
Diversity conserved	1,350+ paddy cultivars; 120 mango and 100 ragi varieties
Conservation plot	One acre; about 5 × 5 ft per paddy variety
Seed sharing	Paddy varieties distributed free to about 20,000 farmers
Rice sales	200+ quintals sold directly each year; IMO-certified organic
Knowledge	Paddy diversity museum (2019) for farmer and student training
Linkages	Shareholder of Sahaja Organics FPC; NABARD collaboration distributing 2–3 varieties per FPO for multiplication
Sustainable energy intervention	Solar-operated seed refrigerator and pre-cleaner



Figure 1.3 — Syed Ghani Khan with his seed collection



Figure 1.4 — Seed stored in labelled jars



Figure 1.5 — Paddy varieties on display

Bibi Fatima, community seed bank, Thirtha, Kundgol taluk, Dharwad.

She formed Bibi Fatima Swa Sahaya Sangha in 2018 with NGO Sahaja Samruddha and six more SHGs, then set up the CSB in 2019. Before the intervention, millets were threshed on mud floors and roads, maize threshers damaged millet and power cuts and finance delayed a processing unit.

TABLE 1.7

Case study: Bibi Fatima, Dharwad

Dimension	Details
Seed diversity	About 300 varieties, incl. 75 finger millet, 25 little millet, 25 brown-top millet, 10 foxtail millet and 2 proso millet
Seed network	Started with 30 seed-producing farmers; SHG-managed
Reach	About 200 farmers from about 22 villages each year
Navadhanya Kit	Nine varieties (pulses, oilseeds, millets, vegetables); free in Haveri, Dharwad, Kalaburagi, Mysuru and Mandya; sold to others
Sustainable Energy interventions intervention	Solar millet processing unit (dehuller with aspirator, size grader, destoner, roti-rolling conveyor); multi-crop electric reaper; multi-crop thresher
Outcomes	Power cuts no longer stop processing; turnover up to ₹30 lakh/year; wider reach and millet-processing knowledge
Market linkage	Shree Anna Grama Yojane (AICRP–Women in Agriculture, CIWA, Odisha) buys quality indigenous millet seed



Figure 1.6 — Bibi Fatima's SHG with seed products



Figure 1.7 — Bibi Fatima's SHG with seed products

1.6 Replication and suitability

The table below shows how suitable this package is for different user groups.

TABLE 1.8

Suitability and Replication Potential

End-user group	Suitability	Rationale
SHGs / Women-led groups	HIGH	Can collectively conserve, store, multiply and distribute traditional seeds while generating income through seed sales.
Farmer Interest Groups / Crop-specific	HIGH	Particularly suitable for conserving indigenous varieties and multiplying seeds adapted to local agro-climatic conditions.
Individual farmers / Seed custodians	HIGH	Farmers with traditional seed knowledge can maintain diverse varieties, undertake seed multiplication and supply seeds to community banks.
Krishi Sakhis	MODERATE	Can mobilise farmers, identify traditional seed varieties, facilitate seed exchange and promote seed conservation practices.
NGOs / Community-based organisations	HIGH	Can facilitate community mobilisation, technical support, documentation of indigenous varieties and institutional linkages.
Individual agri-entrepreneurs	MODERATE	Can undertake seed cleaning, grading, processing and storage as a service enterprise, subject to seed demand and quality requirements.
FPOs / FPCs	HIGH	Can organise seed multiplication, procurement, quality management and distribution among member farmers.

Overall, this package is most suitable for SHGs, FPOs/FPCs and traditional seed-saving farmer groups. Individual farmers play an important role as seed custodians and seed multipliers, while Krishi Sakhis can help mobilise the community and distribute seed.

1.7 Scheme convergence

Community seed banks can link with the schemes and institutions listed below.

TABLE 1.9

Scheme and institutional linkages

Linkage	Relevance to this package
NABARD	Bulk distribution of paddy varieties through FPOs for multiplication
Shree Anna Grama Yojane (AICRP–Women in Agriculture, CIWA)	Institutional purchase of quality indigenous millet seed

PACKAGE 2

Soil Testing Centers

2.1 Overview and need

Soil testing is a scientific check of the soil to find out its nutrient levels, pH, salt content (salinity) and organic carbon. The results are given to the farmer on a Soil Health Card (SHC). The card tells the farmer which nutrients, organic inputs or soil treatments are needed for that field. The main parameters checked in a soil test are given below.

TABLE 2.1

Key soil parameters

Parameter	What it indicates
Macronutrients	Nitrogen (N), Phosphorus (P), Potassium (K) and Sulphur (S) status
Micronutrients	Zinc, iron, copper, manganese and boron status
Soil pH	Whether soil is acidic, neutral or alkaline
Electrical conductivity (EC)	Level of soluble salts in soil
Organic carbon (OC)	Soil organic matter and overall soil health

Need and importance of soil testing

- **Imbalanced nutrient application:** Many farmers apply the same standard (blanket) dose of NPK fertiliser to every field. As a result, some nutrients are applied in excess, while shortages of secondary nutrients and micronutrients are left untreated.
- Excess usage of certain fertilizers can adversely impact soil health, and use of chemicals to increase productivity, can pollute both water and soil.
- **Hidden nutrient deficiencies:** Shortages of sulphur, zinc, boron and other micronutrients are often not noticed. Even when farmers apply the main fertilisers, these hidden shortages can reduce crop growth and yield.

- **Rising cultivation costs:** When farmers apply fertiliser without knowing what the soil actually needs, they spend money on inputs that are not required, and the crop does not use the nutrients efficiently.
- **Soil acidity and nutrient availability:** In areas with acidic soil, especially parts of the North-East, crops cannot take up nutrients easily. Such soils need treatments like lime to correct the problem.
- **Nutrient depletion under continuous cultivation:** Every harvest takes nutrients out of the soil. If these nutrients are not put back, soil fertility slowly goes down and long-term productivity suffers.
- **Field-specific nutrient requirements:** Soil fertility is different from plot to plot, even within the same village. Testing each field helps farmers avoid using the same fertiliser dose on different types of soil.
- **Gap between testing and adoption:** Even when farmers get a soil health report, they may find it hard to understand the results and turn them into the right fertiliser use. This is why local advisory support is needed along with testing.

Constraints faced by remote farmers in accessing soil testing centers

1. **Geographical accessibility:** Soil testing laboratories are usually located at district or block headquarters, so farmers from remote villages have to travel long distances to reach them.
2. **High transportation costs:** The cost of travel and of carrying soil samples to the laboratory adds to the total cost of getting the soil tested.
3. **Delayed test results:** Collecting, transporting and testing the samples takes time. When results come late, farmers cannot use them for timely decisions on crop planning and fertiliser use.
4. **Limited awareness:** Many farmers do not know how soil testing is done, why it should be done regularly or how to read a soil health report.
5. **Inadequate testing infrastructure:** Remote and hilly areas often have very few laboratories, and these have limited trained staff and equipment.
6. **Irregular electricity supply:** Regular soil testing equipment needs a steady power supply, which is difficult to get in off-grid villages and in villages with frequent power cuts.

7 **Language and technical barriers:** Soil health reports often use technical terms. Farmers find it difficult to understand them and turn them into practical steps on their farm.

8 **Limited last-mile service delivery:** Farmers often have no local institution or trained person nearby who can collect samples, arrange the testing and follow up with advice.

TABLE 2.2

Relevance of decentralised, renewable energy-powered, soil testing centers

Sl.No.	Existing constraint	How DRE-driven centers address it
1	Long distances to laboratories	Establishes testing facilities closer to farming communities.
2	High transportation costs	Reduces repeated travel and sample transportation.
3	Delayed test results	Enables local, quicker soil testing and reporting.
4	Unreliable electricity	Solar power supports equipment operation in remote locations.
5	Limited technical support	Creates opportunities for trained local operators and agri-entrepreneurs.
6	Poor interpretation of results	Enables integration of local-language advisory and crop-specific recommendations.

Technologies

Soil can now be tested on-site with a portable device. The device recommended for this package is summarised below and described in detail after the table.

TABLE 2.3

Soil testing technology

Equipment	What it does	Capacity	Key features
NutriSensX portable electrochemical soil tester	On-site chemical soil test; results on smartphone via cloud, with fertilizer recommendations	Up to 25 samples/day	Tests pH, EC, nitrate, phosphate, potassium and organic carbon; electricity-free; instant results; 55 g; vendor claims up to 40% fertilizer cost

NutriSensX — on-site chemical soil testing device

NutriSensX is a portable electrochemical device. It tests the soil on-site and gives the results along with fertiliser recommendations.



Figure 2.1 — NutriSensX portable soil testing device with smartphone app

TABLE 2.4

NutriSensX — specifications

Parameter	Specification
Machine type	Portable electrochemical soil-testing device
Application	On-site soil health testing
Soil preparation	Dried and sieved soil
Testing method	Chemical, using reagents, a sensor and a cartridge
Sensor type	Electrochemical
Parameters tested	pH, EC, nitrate, phosphate, potassium, organic carbon
Testing capacity	Up to 25 samples/day
Power requirement	Electricity-free
Result time	Instant
Soil compatibility	Different soil types and regions
Data connectivity	Cloud data accessible on a smartphone

Parameter	Specification
Advisory system	Fertilizer-input recommendations
Accuracy	Highly accurate (vendor claim)
Cost benefit	Up to 40% fertilizer cost reduction (vendor claim)
Weight	55 g

2.6 Replication and suitability

The table below shows how suitable this package is for different user groups.

TABLE 2.5

Suitability and Replication Potential

End-user group	Suitability	Rationale
FPOs / FPCs	HIGH	Best suited for collective ownership, offering soil testing services to member farmers and generating revenue through service fees.
SHGs	HIGH	Suitable for women-led enterprises to provide village-level soil testing services and diversify livelihood activities.
Farmer Interest Groups (FIGs) / Crop-specific groups	HIGH	Can share equipment costs and access collective soil testing and crop-specific nutrient recommendations.
Krishi Sakhis	HIGH	Can be trained to collect soil samples, operate testing devices, facilitate soil testing at village level and communicate results and nutrient management recommendations to farmers.
Individual agri-entrepreneurs / Rural youth	HIGH	Can operate devices as fee-based service providers, catering to multiple farmers across villages.
Individual farmers	LOW	Less viable for individual ownership due to equipment investment, maintenance and limited testing frequency; better suited to accessing shared testing facilities.
NGOs / Cooperatives	HIGH	Can establish community-level testing facilities and integrate soil diagnostics with sustainable agriculture programs.

Overall recommendation

FPOs/FPCs, SHGs, Krishi Sakhis and crop-specific farmer groups should be given priority. Krishi Sakhis are especially important as last-mile service providers, because they connect the decentralised soil testing centres with individual farmers. Individual farmers are better placed as users of the service rather than as owners of the equipment.

PACKAGE 3

Bio-Resource Centers

3.1 Overview and need

A Bio-Resource Centre (BRC) is a facility at the community level. It prepares, stores and distributes natural and bio-based farm inputs using resources available locally. Because these inputs are made and sold within the village, small and marginal farmers can get them easily and at a lower cost, and they depend less on chemical inputs bought from outside. The main products of a BRC are listed below.

TABLE 3.1

Core BRC products

Product	What it is	Use
Vermicompost	Manure produced by earthworms from biodegradable organic waste	Adds organic matter and nutrients to soil
Jeevamrutha	Fermented, cow-based liquid formulation	Liquid input in natural farming
Microbial bio-inputs (MicroMagic)	Decentralized cultures: Phosphate Solubilizing Bacteria (PSB), Potassium Mobilizing Bacteria (KMB), Zinc Mobilizing Bacteria (ZMB), Azotobacter, Azospirillum, Rhizobium, Pseudomonas, Trichoderma, Bacillus and others	Crop nutrition or biological crop protection, by formulation

Why BRCs are important:

- **Lower input costs:** inputs made locally reduce the need to buy inputs from outside suppliers.

- **Access:** natural farming inputs are available in or near the village.
- **Waste to resource:** farm waste, livestock waste and other biodegradable waste are turned into useful inputs.
- **Soil health:** organic inputs build up organic matter in the soil and support the natural cycling of nutrients.

3.2 Services offered

A BRC makes inputs from local raw materials through composting, fermentation or other methods of preparation. It stores these inputs in suitable conditions and supplies them to farmers, SHGs and FPO members. The services it offers are:

- Sale of vermicompost, both wholesale and retail
- Sale of Jeevamrutha to farmers who cannot prepare it on their own farm
- Production of microbial cultures on-site, matched to the needs of the crop
- Sale of composting earthworms to new units
- Conversion of local waste, such as arecanut husk, into a base material for compost

3.3 Technologies

Vermicompost pit: A vermicompost pit is a shaded, moist and well-aerated bed. In this bed, earthworms and microbes turn farm residues, cow dung and other biodegradable material into stable manure. The quality of the compost depends on the raw material used, moisture, aeration, earthworm activity and how mature the compost is. Vermicompost alone may not meet all the nutrient needs of a crop. The materials needed for a pit are given below.

TABLE 3.2

Vermicompost pit material

Material	Quantity	Purpose
Sand or morang	3-inch layer	Transition layer for drainage
Wet soil	6-inch layer	Moist base for earthworms
Dry organic matter	200–300 kg	Carbon-rich material

Material	Quantity	Purpose
Decomposed farmyard manure	300–400 kg	Supports microbial activity
Biodegradable organic waste	700–800 kg	Additional feedstock
Composting earthworms	Not specified	Convert pre-decomposed matter into vermicast
Water; jute sack or breathable cover	As required	Keep bed moist; shield from sun

The process is as follows:

1. Prepare a pit or bed in a shaded place with good drainage, and lay the drainage layers.
2. Add organic material that is partly decomposed, and then add the earthworms.
3. Keep the bed moist but not waterlogged. Protect it from the sun and from predators, and do not add fresh waste, because it heats up.
4. Harvest the compost when the material turns dark, crumbly and mostly decomposed.

TABLE 3.3

Example vermicompost unit designs

Unit type	Dimensions	Reported cost	Reported output
Readymade plastic bed	3 × 1.2 × 0.6 m	₹1,200 per bed	210 kg per batch
Kadappa stone bed	4.2 × 0.75 × 0.9 m	₹9,800 per bed	150 kg per batch
Lateritic stone bed	4.2 × 0.75 × 0.9 m	₹9,100 per bed	140 kg per batch

These figures are taken from Indian agricultural research sources and are not current price quotations. The designs are also different from each other, so they cannot be compared directly. Along with the pit, a BRC uses a few machines to process, pack and produce inputs. These are listed below

TABLE 3.4

BRC equipment

Equipment	What it does	Key specification
Shredding machine	Cuts residues, leaves and straw for faster decomposition	10 HP three-phase; 1,000 kg/hour
Sieving machine	Separates finished vermicompost for packing and sale	1.5 HP single-phase; 1,500 kg capacity
Bag stitching machine	Seals PP, jute, paper and fertilizer sacks	5–8 bags/minute; 5 kg portable
MicroMagic MM-600-PRO	On-farm fermentation unit for microbial inputs	Supplier dose 4 L/acre (10 L/ha), to confirm per product
Solar dryer	Dries organic material such as arecanut husk	75 kg to 4 tonnes
Arecanut husk shredder	Shreds husk for composting, mulch and biomass uses	10 HP three-phase; 1,200–1,500 kg/hour rated

Before investing in a Micro Magic unit, a BRC should check the demand, the regular cost of media and culture kits, whether an operator is available, power and water supply, quality control and the cost of distribution.

Micro Magic MM-600-PRO microbial fermentation unit

This is a fermentation unit for use on the farm. It produces microbial inputs locally, matched to crop needs, so that fresh inputs are available at the critical stages of the crop.

TABLE 3.5

Micro Magic MM-600-PRO — specifications

Parameter	Specification
Users	Farmers, FPCs, KVKs, NGOs, development projects, farming clusters
Crops	Vegetables, fruits, cereals, plantation crops
Cultures	PSB, KMB, ZMB, Azotobacter, Azospirullum, Rhizobium, Pseudomonas, Trichoderma, Bacillus and others
Recommended dose	4 L/acre (10 L/ha) per supplier quotation; confirm per product
Vendor	Micro Magic

3.4 Business models

Two vermicomposting models have been costed: a large unit that runs continuously and a 15-bed unit that runs in batches. Both models assume an 80% loan and 20% own contribution, at 12% interest over 60 months.

TABLE 3.6

Vermicomposting unit: setup and investment

Item	Model A: large continuous unit	Model B: 15-bed batch unit
Format	130 × 25 ft shed (~300 m^2), continuous flow	15 beds (15 × 3 × 3 ft), 3 cycles/year
Annual output	100 t	45 t
Total CAPEX	**₹20 L**	**₹2.63 L**
Financing (80:20)		Loan ₹2.1 L; margin ₹52.5k
CAPEX items	Shed ₹5 L; priming compost ₹6 L; farm house ₹3 L; worms ₹2 L; sieving machine ₹2 L; working capital ₹2 L	Beds ₹45k; roofing ₹19k; chaff cutter ₹30k; blower ₹30k; sieving machine ₹60k; worms ₹79k
EMI	₹35,591/month (₹4.27 L/year)	₹4,671/month (₹56k/year)

TABLE 3.7

Vermicomposting unit: annual unit economics

Line	Model A	Model B
Vermicompost revenue	100 t wholesale at ₹11/kg = ₹11 L	31.5 t wholesale at ₹13 + 13.5 t retail at ₹20 = ₹6.8 L
Earthworm revenue	75 kg at ₹700 = ₹52.5k	65 kg at ₹800 = ₹52k
Total revenue	**₹11.53 L**	**₹7.32 L**
Raw material	100 t at ₹2/kg = ₹2 L	45 t at ₹7/kg = ₹3.15 L
Labour (2 × ₹350 × 300 days)	₹2.1 L	₹2.1 L

Line	Model A	Model B
Packaging, transport, power, maintenance	₹72k	₹32.5k
Total OPEX	**₹4.82 L**	**₹5.58 L**
Operating profit (margin)	₹6.71 L (58%)	₹1.74 L (24%)
Surplus after EMI	₹2.43 L	₹1.18 L
Payback (CAPEX ÷ operating profit)	3.0 years	1.5 years

The surplus after EMI is calculated before depreciation and tax.

3.5 Case studies

R. Lohith, arecanut husk to organic inputs.

A graduate in agriculture with expertise in mushroom cultivation and organic input preparation, he operates independently without being associated with an SHG or FPO. He has received several state and university-level recognitions, including the Best Agri-Entrepreneur Award from Keladi Shivappa Nayaka University of Agricultural and Horticultural Sciences.

Previously, arecanut husk was discarded along roadsides and took nearly two years to decompose. With support from SELCO Foundation, he established an integrated drying, shredding and vermicomposting process.

Processing and conversion process:

- **Drying:** 100 kg of wet arecanut husk yields approximately 80 kg of dry husk.
- **Shredding:** Further processing produces approximately 15 kg of powder, which serves as a carbon-rich base.
- **Composting preparation:** The powder is mixed with cow dung/FYM, kitchen waste or green biomass and soil.
- **Pre-decomposition:** The mixture is allowed to decompose for 10–15 days before introducing earthworms for vermicomposting.

TABLE 3.8

Case study: R. Lohith — intervention and outcomes

Dimension	Details
Solar drying	Drying time cut from about two months (sun) to about three days
Husk shredding	Dried husk to powder at 15–20 kg/hour in use
Vermicomposting	Husk powder used as compost base; speeds decomposition
Waste outcome	Husk composts in a few weeks instead of up to two years
Farm benefits	Potential gains in soil organic matter, faster compost, lower fertilizer cost
Impact	Following the technology adoption, he produces approximately 3,000 kg of vermicompost every three months, which is sold at ₹15 per kg. This generates a revenue of ₹45,000 per quarter, equivalent to ₹15,000 per month.

Solar dryer (Case 3.1)

The solar dryer is a closed unit that uses solar energy to remove moisture from produce, food and other organic material.



Figure 3.1 — Solar dryer used for arecanut husk

TABLE 3.9

Solar dryer (Case 3.1) — specifications

Parameter	Specification
Capacity	75 kg to 4 tonnes, by model
Uses	Seeds, vegetables, fruits, leafy vegetables
In use	Cuts arecanut husk drying from about two months to about three days

Solar dryer (Case 3.1)

This compact machine shreds arecanut husk for composting, mulching, biomass processing and other value-added uses.



Figure 3.2 — Arecanut husk shredder

TABLE 3.10

Arecanut husk shredder — specifications

Parameter	Specification
Power	Electric (AC), 10 HP, 415 V / 50 Hz, three-phase
Rated capacity	1,200–1,500 kg/hour
Throughput in use	15–20 kg of dry husk per hour
Size; weight	4.6 × 2.6 × 4.9 ft; 200 kg

3.6 Replication and suitability

The model is well suited to individual farmers, FPOs/FPCs and SHGs. Individual farmers can set up small units to meet the needs of their own farm, while farmer groups and entrepreneurs can run larger units on a commercial basis. The main limit on replication is the availability of livestock-based inputs such as cow dung and urine, along with enough organic biomass.

3.7 Scheme convergence

Bio-Resource Centres can draw support from the scheme listed below.

TABLE 3.11

Scheme convergence: Bio-Resource Centers

Scheme	Relevance to this package	Key support
National Mission on Natural Farming (NMNF)	Targets 10,000 cluster-level BRCs as one-stop shops for ready-to-use natural farming inputs	₹1 lakh per BRC, in two ₹50,000 instalments, excluding permanent infrastructure

PACKAGE 4

On-Farm Practices and Zero-Tillage Farming

4.1 Overview and need

On-farm practices and zero-tillage farming help farmers grow crops in a sustainable way. They disturb the soil less, use resources efficiently and improve soil health. In zero tillage, seeds are sown directly into the soil without ploughing, which reduces the cost of land preparation, fuel and labour. These practices help farmers deal with falling soil fertility, moisture stress, soil erosion, rising cultivation costs and late sowing. They also help in managing crop residue, sowing on time and building long-term resilience, especially for small and marginal farmers. The main regenerative practices are listed below.

TABLE 4.1

On-farm regenerative practices

Practice	What it involves
Minimal soil disturbance and zero tillage	Avoid routine ploughing; establish crops with direct-seeding equipment
Crop-residue retention	Keep residues on the surface to protect topsoil, cut evaporation and limit erosion
Precision sowing	Place seed at suitable spacing and depth; avoid excess seed use
Permanent raised beds and furrows	Guide water, improve drainage, reduce waterlogging
Crop rotation and multicropping	Rotate with pulses, vegetables and other crops across seasons
Soil organic matter and biology	Use residues and organic inputs to build structure and soil life

Practice	What it involves
Water conservation and drainage	Manage cover, layout and drainage to local rainfall and soil
Integrated weed and pest management	Combine mechanical, cultural and local methods, not tillage alone
Appropriate mechanisation	Use a multipurpose toolbar and compatible implements

These practices are important for the following reasons:

- **Reduced cultivation costs:** Farmers spend less on tractor work, fuel, labour and land preparation.
- **Soil moisture conservation:** Because the soil is disturbed less and crop residue is left on the surface, the soil holds more moisture.
- **Improved soil health:** Less disturbance supports the activity of soil microbes and improves the structure of the soil over time.
- **Reduced soil erosion:** Crop residue left on the field protects the soil surface from wind and water erosion.
- **Timely sowing:** Crops can be established faster, which helps where delays in land preparation upset the cropping calendar.
- **Climate resilience:** Using less fuel reduces emissions, and crops cope better with moisture stress.
- **Improved resource efficiency:** Water, labour and farm machinery are used more efficiently.
- **Multiple cropping opportunities:** The gap between one crop and the next is shorter, so the next crop can be sown on time.

4.3 Technologies

The technology used in this package is the Saguna Regenerative Technique (SRT) toolbar. It is built around an INAV electric three-wheeler, which carries and powers a set of compatible implements. The components of the toolbar are listed below.

TABLE 4.2

SRT toolbar set components

Component	Function
Vehicle / power platform	Hauls loads; operates implements
4 ft reaper	Cuts mature crops
Seed drill	Places seed at adjustable spacing
DC sprayer	Applies liquid inputs
Flail mower	Vegetation management
Trench repair tool	Repairs trenches and furrows
Charging system	Recharges vehicle battery



Figure 4.1 — SRT toolbar set in the field

4.4 Business models

The business model is worked out for one acre farm in Maharashtra. It compares farming with SRT and the e-Zebu toolbar against conventional paddy-based farming. The investment and cost assumptions are given first, followed by the profit per acre.

TABLE 4.3

Investment and cost assumptions (per acre)

Item	Conventional	SRT + e-Zebu	Notes
Upfront investment (CAPEX)	–	₹523,967	9 items incl. 5% GST; e-Zebu platform alone is ₹2,89,275 (55%)
Financing	–	80% loan at 12% → over 5 yrs EMI ₹9,324/month (₹1,11,891/yr)	20% margin (₹1,04,793) is not counted anywhere in the model
Crops per year	2 (paddy + summer veg)	3 (paddy + soybean + summer veg)	SRT land turnaround is 4 days vs 30–45 days
Paddy operating cost	₹50,689	→ ₹25,215 (Y0) ₹15,965 (Y3+)	Biggest savings: fertiliser, transplanting labour, weeding; adds ₹4,100/yr charging + maintenance
Total annual expenses in P&L	**₹62,689**	**₹43,215**	**Includes hard-coded other-crop costs (₹12,000 conventional; ₹18,000 SRT)**
Yield vs conventional	–	+30% in Y0, then +15%, +15%, +10%	Applied to every crop

TABLE 4.4

Profitability per acre (₹/year)

₹ per acre per year	Conventional	SRT Y0	SRT Y1	SRT Y2	SRT Y3+
Revenue	187,500	339,430	390,345	448,896	493,786
Expenses	62,689	43,215	43,215	43,215	43,215

₹ per acre per year	Conventional	SRT Y0	SRT Y1	SRT Y2	SRT Y3+
Operating profit	124,812	296,215	347,130	405,681	450,571
Loan repayment (EMI)	–	111,891	111,891	111,891	111,891
Net profit	**124,812**	**184,324**	**235,238**	**293,790**	**338,679**

> **Payback as modelled: 5.1 years.**

4.5 Case studies

The farmer was growing paddy, vegetables and other pulse crops and the main challenges he was facing was high labour cost, increased cost of cultivation, we were able to identify the end user from one of the partner organization from Sagunabaug.

TABLE 4.5

Case study: Parshuram Tatu Agivale — SELCO–SRT intervention

Intervention	Purpose and details
Saguna Regenerative Technique	No-till regenerative approach since 2013: zero tillage, residue retention, precise seed placement, soil-carbon rebuilding, water conservation
SRT toolbar	Forms permanent broad beds; uniform spacing and seed placement; less compaction; 60–70% labour reduction
Permanent raised beds and furrows	Faster drainage; protects roots from waterlogging in high rainfall
Precision sowing at first rain	Less seed, early germination, uniform plant stand
Root decomposition and residue-based soil improvement	Builds organic matter and microbial activity
Multicropping	Kharif paddy, rabi vegetables or pulses, summer vegetables

TABLE 4.6

Case study: Parshuram Tatu Agivale — outcomes before and after SRT

Dimension	Before SRT	After SRT
Annual income	₹7,000–8,000	₹1.7–2 lakh
Crop seasons	1	3
Labour	Very high	About 70% lower
Seed requirement	High	60% lower
Ploughing	3–4 times a year	None after first setup
Soil condition	Low carbon; erosion	Softer, more porous; better organic carbon and water retention
Pests and diseases	High incidence	Significantly lower
Climate resilience	Vulnerable to erratic rain and waterlogging	Better drainage; stable yields

Recognition includes the Adarsh Shetkari Award (2015), the Vasantrao Naik Vansheti Krishi Pratishthan Award (2016), the SRT Sarvamkrisht Shetkari Krishi Samman (2019) and the SRT Best Pracharak Award (2025) from the Chief Minister of Maharashtra.

4.6 Replication and suitability

The table below shows how suitable this package is for different user groups.

TABLE 4.7

Suitability and Replication Potential

End-user group	Suitability	Rationale
FPOs / FPCs	HIGH	Best suited for collective investment and providing paid machinery services to member farmers across multiple villages.
Custom Hiring Centres (CHCs)	HIGH	Can recover investment through rental services and improve equipment utilisation across multiple farmers.
Large farmer groups / FIGs	HIGH	Shared ownership distributes the high capital cost among participating farmers.

PACKAGE 5

IoT-Based Precision Farming and Weather Stations

5.1 Overview and need

IoT-Based Precision Farming

- IoT-based precision farming uses connected sensors, automatic weather stations and digital tools to collect real-time data from the field. This data helps farmers take better decisions on irrigation and crop management.

Relevance to horticulture and climate-resilient farming

- **Water-use efficiency:** Data on soil moisture and rainfall helps farmers irrigate when the crop needs water, instead of at fixed intervals. In paddy, checking the water level can support Alternate Wetting and Drying (AWD).
- **Climate resilience:** Local weather data helps farmers plan irrigation and field work according to changing rainfall and weather.
- **Heat-stress management:** Readings of temperature, humidity and leaf wetness help identify when the crop may be under stress, so that farmers can inspect the field and take action in time.

Technologies

> The main IoT technologies and their uses are listed below, followed by the specific devices and packages used in the field.

TABLE 5.1

Key IoT technologies and uses

Technology	Use
Soil moisture sensor	Shows root-zone water availability to guide irrigation
Weather station	Records rainfall, temperature, humidity, wind and related conditions
Crop-environment sensors	Track temperature, humidity, leaf wetness and microclimate
IoT irrigation controller	Controls water delivery by thresholds or schedules
AWD water-level device	Monitors standing water in paddy fields
Mobile dashboard and alerts	Make readings and trends available to farmers and advisers

TABLE 5.2

IoT devices and packages in detail

Device or package	Purpose
Nero Pulse AWD water-level device	Measures paddy-field water level for AWD
Kairo compact weather station	Records local weather and soil conditions
Nero soil-sensing device	Touchless soil measurement for irrigation decisions
IoT irrigation and fertigation package	Sensor-based drip with automated pumping, fertigation and remote monitoring

5.4 Business models

The irrigation business model compares three levels (tiers) of technology on 3 acres of arecanut. All three tiers include the same solar system costing ₹6 lakh. Automation (Tier C) gives the biggest savings and the shortest payback period.

TABLE 5.3

IoT irrigation: CAPEX and financing by technology tier (3 acres)

Line	Tier A: drip only	Tier B: drip + sensors (manual)	Tier C: drip + sensors + IoT (auto)
Drip hardware (₹55k/acre)	₹165,000	₹165,000	₹165,000
Soil sensors (12 at ₹13,500)	—	₹162,000	₹162,000
Gateway, pump controller, auto valves	—	—	₹115,000
Solar system	₹600,000	₹600,000	₹600,000
Pump (3 HP) and installation (₹5k/acre)	₹45,000	₹45,000	₹45,000
Gross CAPEX	**₹810,000**	**₹972,000**	**₹1,087,000**
PMKSY subsidy (50% of drip)	₹82,500	₹82,500	₹82,500
Net CAPEX	**₹727,500**	**₹889,500**	**₹1,004,500**
EMI (80% loan on gross CAPEX, 12%, 60 months)	₹14,414/month (₹1.73 L/year)	₹17,297/month (₹2.08 L/year)	₹19,344/month (₹2.32 L/year)

Note: the subsidy rate used here (50%) is different from the scheme rates given in section 5.7

TABLE 5.4

IoT irrigation: annual economics, 3 acres of arecanut

Line	Baseline (pre-drip)	Tier A	Tier B	Tier C
Revenue (800 kg/acre at ₹300/kg)	₹720,000	₹720,000	₹720,000	₹720,000
Pump energy or diesel	₹16,500	—	—	—

Line	Baseline (pre-drip)	Tier A	Tier B	Tier C
Water tanker	₹90,000	—	—	—
Labour (irrigation and fertigation)	₹63,000	₹37,800	₹37,800	—
Fertilizer	₹36,000	₹36,000	₹27,000	₹27,000
Pesticide and spraying	₹30,000	₹30,000	₹22,500	₹22,500
System AMC	—	—	—	₹500
Total OPEX	**₹235,500**	**₹103,800**	**₹87,300**	**₹50,000**
Operating profit	₹484,500	₹616,200	₹632,700	₹670,000
Saving vs baseline	—	₹131,700	₹148,200	₹185,500
Profit after EMI	₹484,500	₹443,227	₹425,133	₹437,875
Payback (gross CAPEX ÷ saving)	—	6.2 years	6.6 years	5.9 years

5.5 Case studies

Case 5.1 — Lakshman, Yadgiri, Karnataka.

A 48-year-old farmer and retired schoolteacher faced several agricultural challenges, including water scarcity, reliance on flood irrigation, high labour costs, soil erosion, pest incidence, low crop yields and distress sales. To address these issues, SELCO Foundation supported him with a solar-integrated IoT-based irrigation and fertigation system, enabling technology-driven water management and more efficient delivery of water and nutrients to crops.

TABLE 5.5

Case study: Lakshman, Yadgiri — outcomes

Indicator	Before	After
Cultivated area	2 acres	4 acres
Seasonal income	₹3 lakh	₹6.5 lakh
Labour cost	—	₹28,000 lower per season
Fertilizer use	—	30 kg less per season

Indicator	Before	After
Water use	Flood irrigation	60–70% saving
Soil and yield	Erosion, low yields	Improved yields



Figure 5.1 — Filter and fertigation unit at Lakshman's farm, Yadgiri

Shoukatali Lambunavar, Nagnur, Navalgund taluk, Dharwad.

A 48-year-old farmer faced severe water scarcity after his borewells failed, leaving him dependent on a rain-fed pond, manual bucket irrigation and costly diesel-powered pumps and rented equipment. SELCO Foundation supported him in integrating a solar-powered IoT irrigation and fertigation system with the existing pond. This enabled the utilisation of stored rainwater for crop irrigation while also supporting fish production, creating an integrated farming system and reducing dependence on conventional irrigation methods.

TABLE 5.6

Shoukatali Lambunavar, Dharwad — outcomes

Indicator	Before	After
Crop survival	About 40%	Nearly 90%
Annual irrigation cost	₹45,000	₹0
Water use	—	50–60% saving

Indicator	Before	After
Labour requirement	High	About 60% lower
Fish harvest cycle	Shortened, inconsistent	6 to 10 months



Figure 5.2 — Shoukatali Lambunavar with the fertigation tanks



Figure 5.3 — Shoukatali Lambunavar at the irrigation filter unit

5.6 Replication and suitability

The table below shows how suitable this package is for different user groups.

TABLE 5.7

Suitability and Replication Potential

End-user group	Suitability	Rationale
Individual farmers	HIGH	Can adopt soil moisture sensors and solar-powered irrigation systems based on farm size, water requirements and investment capacity.
Farmer groups / FIGs	HIGH	Can collectively invest in shared technologies and services, reducing individual investment costs.
FPOs / FPCs	HIGH	Can invest in weather stations, pest-detection systems and soil-testing facilities, providing services to a larger number of member farmers and reducing the cost per farmer.

5.7 Scheme convergence

IoT-based precision farming can draw support from the scheme listed below.

TABLE 5.8

Scheme convergence: IoT precision farming

Scheme	Relevance to this package	Key support
PMKSY – Per Drop More Crop (PDMC)	Micro-irrigation (drip, sprinkler) with fertigation; reduces groundwater extraction	55% subsidy for small and marginal farmers, 45% for others, up to 5 ha; via RKVY and DBT

TABLE 5.9

Scheme Convergence: Rashtriya Krishi Vikas Yojana (RKVY)

Component	Support
Scheme and ministry	PM-RKVY, Ministry of Agriculture and Farmers Welfare
Objective	Flexible state funding for agriculture and allied projects, including pre-and post-harvest infrastructure
Funding pattern	60:40 Centre–State; 90:10 for North-Eastern and hilly states
Key components	Per Drop More Crop, farm mechanisation, soil health, PKVY, rainfed area development, agro-forestry
State projects	Infrastructure projects approved through the state's Annual Action Plan
Agri-startups	Grants up to ₹5 lakh (pre-seed) and ₹25 lakh (seed) through R-ABIs
Target beneficiaries	Farmers, FPOs/FPCs, SHGs, cooperatives and agri-startups, via state departments

PACKAGE 6

Bio-Input and Vermicompost Preparation and Application

6.1 Overview and need

Bio-inputs are products made from plants, animals or microbes. They are applied to crops or soil to improve productivity, quality and plant health (FAO). Their value is not just as a simple replacement for chemical fertiliser. Instead, they change the biological processes that control nutrient availability, root growth, stress tolerance and pest control. How well they work in the field depends on soil pH, moisture, nutrient status, the crop, the microbes already present in the soil and the formulation. For this reason, the focus is now shifting to solutions designed for a specific crop, soil and purpose.

Bio-inputs can help in the following ways:

- Add nutrients or make them available to the crop, through nitrogen fixation, phosphate solubilisation and potassium mobilisation.
- Help the crop use nutrients from the soil and from applied fertiliser more efficiently.
- Stimulate root and plant growth and change the root zone (rhizosphere).
- Help crops tolerate drought, salinity, temperature and nutrient stress.
- Control pests and diseases through biological means.
- Rebuild microbial activity and nutrient cycling in the soil.

Under Integrated Nutrient Management, bio-inputs are most useful when they improve the efficiency of the whole nutrient system, rather than replacing all fertiliser. ICAR's Bio-NPK, Bio-Phos and Bio-Zinc follow this approach. The main types of bio-inputs are listed below.

TABLE 6.1

Types of bio-inputs

Type	What it is
Biofertilizers	Living microbes (Rhizobium, Azotobacter, PSB) that fix nitrogen and unlock soil nutrients; liquid inputs such as Jeevamrutha enrich soil fertility
Biopesticides	Natural agents (Bacillus thuringiensis, fungi, plant extracts) that control target pests and diseases
Biostimulants	Substances or microbes that enhance growth, roots and stress tolerance
Organic fertilizers	Compost and vermicompost that improve structure and supply macro- and micronutrients
Indigenous seeds	Locally adapted varieties that support biodiversity and resilience (see Package 2)

Positioning Jeevamrutha. Studies show that Jeevamrutha increases microbial diversity, soil organic carbon, nitrogen-fixing and phosphate-solubilising microbes, and enzyme activity in the soil. When it was applied at 1,000 L/ha on an Alfisol soil in Karnataka, available nitrogen and the crop's uptake of N, P and K went up. NITI Aayog found that Jeevamrutha has a large microbial population but a low total nutrient content. A study on maize found that 1,500 L/ha could reduce the need for inorganic nutrients by about 25%, and that Jeevamrutha with vermicompost worked better than Jeevamrutha alone. So, Jeevamrutha is best described as a biological catalyst that boosts soil microbial activity and makes nutrients available. It is not a high-nutrient fertiliser.

6.2 Services offered

A bio-input unit can offer the following services:

- Production of Jeevamrutha for use on the producer's own farm
- Sale of Jeevamrutha to farmers who do not have livestock or the time to prepare it
- Production of vermicompost for own use and for sale (the enterprise model is covered in Package 3)
- Demonstrations and adoption support for neighbouring farmers, from farmer to farmer

- In the field case, gifting desi cows to new natural farmers, so that not having livestock does not stop them

6.3 Technologies and equipment

TABLE 6.2

Scalable bio-inputs and associated technology

#	Bio-input	Associated technology
1	Vermicompost	Vermicompost bins, shredders, sieving machines (see Table 3.4)
2	Jeevamrutha	Biofermenters and biodigesters

Biodigesters break down manure, food waste and crop residues without air (anaerobically). This produces biogas and a nutrient-rich digestate. Biofermenters provide controlled conditions to ferment organic material into liquid microbial inputs. Both turn farm residues into useful inputs and reduce the need to buy products from outside. The ingredients needed to prepare 200 litres of Jeevamrutha are given below.



Figure 6.1 — Jeevamrutha biodigester

TABLE 6.3

Ingredients for 200 litres of Jeevamrutha

#	Ingredient	Quantity	Purpose
1	Fresh cow dung	10 kg	Primary microbial inoculum and organic nutrients
2	Cow urine	5–10 L	Soluble nutrients and compounds for microbial activity
3	Jaggery	2 kg	Sugars and carbon that drive microbial multiplication
4	Pulse flour	2 kg	Nitrogen-containing compounds for microbial growth
5	Farm or bund soil	1 handful	Native, locally adapted soil microbes
6	Water	200 L	Medium for growth and fermentation

The mixture should be stirred regularly to keep the ingredients mixed and aerated, and kept in the shade to prevent overheating. The biodigester comes in different capacities, as shown below.

TABLE 6.4

Biodigester capacity variants and cost

#	Capacity	Technology cost
1	1,500 L	₹18,262
2	2,500 L	₹24,570
3	5,000 L	₹34,276

Jeevamrutha biodigester

This closed unit continuously processes cow dung, cow urine, jaggery, buttermilk and organic waste into Jeevamrutha that is rich in microbes. Anaerobic digesters also produce biogas and a nutrient-rich digestate

TABLE 6.5

Jeevamrutha biodigester — specifications

Parameter	Specification
Capacities	1,500 L, 2,500 L and 5,000 L (costs in Table 6.4)
Working fill (1,500 L unit)	1,125 L

Parameter	Specification
Stabilisation period	50 days
Net output (1,500 L unit)	About 45 L/day
Inputs	Cow dung, cow urine (gomutra), jaggery, buttermilk, organic waste
Labour	Minimal daily labour once running (Case 6.1)

6.4 Business models

The cost of the 1,500-litre unit has been worked out for three options: selling all the output, using it only on one acre of the owner's farm, or using it on the owner's farm and selling the surplus. Using it only on one's own farm does not recover the cost, but selling the surplus recovers it within a few months.

TABLE 6.6

1,500-litre Jeevamrutha unit: setup, production and operating cost

Element	Value
CAPEX (tank, plumbing, civil work)	₹18,000
Financing, case 1 (fully financed)	Loan ₹14,400 at 12% over 36 months (EMI ₹478/month); margin money ₹3,600
Financing, case 2 (50% gap support)	Gap support ₹9,000 + promoter down payment ₹9,000
Digester	1,500 L capacity; 1,125 L working fill; 50-day stabilisation
Operating period	30 days/month; 10 months in year 1, 12 months after
Production	45 L/day net: 13,500 L in year 1, 16,200 L from year 2
One-time start-up inputs	₹2,150 (jaggery, buttermilk)
Labour	₹20,000/year, one person
Total operating cost	**₹49,150 in year 1; ₹52,400 from year 2**
Selling price	₹10/litre

Element	Value
Self-use absorption	5,000 L/acre/year; leaves 8,500 L surplus in year 1 and 11,200 L from year 2
Fertilizer saving	₹6,000/acre/year (800 →400 g/plant, 500 trees, ₹30/kg)

TABLE 6.7

1,500-litre Jeevamrutha unit: returns under three business routes

Line	Sell all output	Self-use only, 1 acre	Own acre + surplus sold
Gross benefit, year 1	₹135,000	₹6,000	₹91,000
Gross benefit, year 2 onward	₹162,000	₹6,000	₹118,000
Operating cost, year 2 onward	₹52,400	₹52,400	₹52,400
Net benefit, year 1 after EMI	₹80,111	(₹48,889)	₹36,111
Net benefit, years 2–3 after EMI	₹103,861	(₹52,139)	₹59,861
Net benefit, year 4 onward	₹109,600	(₹46,400)	₹65,600
Payback on CAPEX	0.21 years	Not recovered	0.43 years

6.5 Case studies

Case 6.1 — Chandru, Kunabevu village, Chitradurga. A natural farmer for over six years on 5 acres of arecanut, ragi, maize, fruit and forest trees. Manual drum preparation was labour-intensive and batch-limited and could not meet a five-acre farm's needs. With SELCO Foundation support he installed a 1,500-litre biodigester as a pilot (date pending, D-13), then scaled to 5,000 litres. The unit processes cow dung, gomutra, jaggery, buttermilk and organic waste with minimal daily labour.

TABLE 6.8

Chandru, Kunabevu — outcomes

Dimension	Outcome
Capacity	Scaled from a 1,500 L pilot to a 5,000 L unit
Production and distribution	25,000+ litres supplied across Karnataka and Andhra Pradesh
Revenue and savings	Not yet reported (D-13)
Village adoption	27 farmers in Kunabevu adopted biodigesters
District reach	80+ farmers across Chitradurga adopted the technology
Environmental and social	Better soil health, less synthetic run-off, better yield quality, community-led adoption

Lessons for programme design: moving from drums to a semi-automated digester cuts labour while raising output; the model works both for internal cost reduction and as an enterprise selling to farmers without livestock; and peer demonstration spreads faster than extension.

6.6 Replication and suitability

TABLE 6.9

Suitability and Replication Potential: Biodigesters and Vermicomposting

End-user group	Suitability	Replication potential
Individual farmers	HIGH	Can establish small-scale biodigesters or vermicompost units using locally available animal dung and farm waste to produce inputs for their own farms, reducing dependence on purchased inputs.
SHGs	HIGH	Can operate shared production units and develop village-level enterprises to prepare and sell bio-inputs to local farmers.
FPOs / FPCs	HIGH	Can establish larger processing units, aggregate animal waste and biomass, and supply or market bio-inputs to member farmers and nearby villages.

End-user group	Suitability	Replication potential
Bio-Resource Centres (BRCs)	HIGH	Can integrate biodigesters and vermicomposting into existing bio-input production facilities, ensuring local availability of organic inputs.
Farmer groups / FIGs	HIGH	Can pool resources, share labour and operate community-level units to meet the input requirements of group members.

6.7 Scheme convergence

Bio-input units can draw support from the scheme listed below.

TABLE 6.10

Scheme convergence: bio-inputs

Scheme	Relevance to this package	Key support
National Mission on Natural Farming (NMNF)	Funds cluster-level BRCs producing ready-to-use bio-inputs	₹1 lakh per BRC in two ₹50,000 instalments, excluding permanent infrastructure

PACKAGE 7

Post-Harvest Loss Management

7.1 Overview and need

Post-harvest losses (PHLs) are any reduction in the quantity, quality, nutrition, market value or safety of produce between harvest and the consumer. They can happen at any stage, from harvesting to marketing. Food loss happens along the supply chain before the produce reaches retail, while food waste happens in retail shops, food services and households. The main types of post-harvest loss are listed below.

TABLE 7.1

Types of post-harvest loss

Type	What is lost
Physical / quantitative	Weight or volume, through spillage, breakage, decay, pests or moisture loss
Qualitative	Colour, texture, taste, nutrition or appearance
Economic	Price, when produce misses market or export specifications
Nutritional	Vitamins, minerals and other nutrients during storage and processing
Food safety	Safety, through microbes, mycotoxins, chemicals or other hazards

Losses are high in India for many reasons: farms are small and scattered; scientific storage and cold-chain facilities are limited; packaging and handling are poor; produce travels long distances; there is no grading at the source; there are seasonal gluts; very little produce is processed; market information is weak; and temperatures are high. So, the

recommended approach is to start from the points where losses happen (loss-point-led), instead of starting from infrastructure (infrastructure-led). The technologies for each loss point are given below.

Technologies

TABLE 7.2

Technologies by loss point

Loss point	Associated technology
Harvesting	Mechanical and improved harvesting technologies
Cleaning, sorting and grading	Washers; size- and colour-based graders
Storage	Cold storage
Packaging	Plastic crates, cushioning, corrugated fibreboard boxes
Processing	IQF, drying and dehydration, pulverisers, slicers

Cold storage

Cold storages slows down respiration, ripening, moisture loss and the growth of microbes, which gives farmers more time to sell. Pre-cooling removes field heat from the produce before it is stored. **Micro cold rooms** are small cold storage units placed close to farmers, such as on farms, FPO collection centres, aggregation points, packhouses, mandis and processing clusters. Their main value is not their capacity but the fact that they bring refrigeration close to the farm. Solar-powered micro cold rooms depend less on unreliable grid power, cost less to run at suitable sites and suit remote areas. Most implemented capacities of the cold storages are 5MT, 10MT and 20 MT.



Figure 7.1 — Solar-powered micro cold rooms



Figure 7.2 — Solar-powered cold room stocked with produce

7.4 Business models

The business model is based on Case 7.1. Sunil Bhilare grows strawberries and blueberries and also buys them from nearby farmers. He stores them in a 10 MT solar cold room for 10–15 days and sells to retail vendors. The cold room has let him roughly double the quantity he trades.

TABLE 7.3

Berry cold room (10 MT): setup and operating cost

Item	Amount	Note
Capital cost	₹1,400,000	10 MT solar cold room, 2–4 °C; financing not given
Transport	₹1,20,000/year	₹10,000/month
Labour	₹72,000/year	₹6,000/month
Power	₹24,000/year	₹2,000/month
Admin	Nil	Not costed
Total operating cost	**₹2,16,000/year**	**₹18,000/month**

TABLE 7.4

Berry cold room (10 MT): annual trading economics

Line	Strawberry	Blueberry	Total
Season	Nov–Jun	Dec–May	
Quantity traded	9,600 kg	1,700 kg	11,300 kg
Buy / sell price	₹200 / ₹300 per kg	₹400 / ₹550 per kg	
Revenue	₹2,880,000	₹935,000	₹3,815,000
Purchase cost	₹1,920,000	₹680,000	₹2,600,000
Gross profit	₹960,000	₹255,000	₹1,215,000
Operating profit			₹999,000
Return on investment			71%
Payback			About 17 months

Other Post harvest loss management technologies

TABLE 7.5

Graders, dryers, slicers and pulverisers

Equipment	What it does	How it reduces loss	SHG and FPO opportunity
Grader	Separates produce by size, weight, shape or quality (paddy, millets, pulses, fruit)	Keeps damaged material from spoiling good produce; improves drying, milling and storage	Sell in separate grades at better value instead of mixed lots
Dryer	Lowers moisture to safe levels for storage and processing	Prevents spoilage and fungal growth; more even than open-air drying	Dry chilli, turmeric, ginger, banana or jackfruit and sell dried products
Slicer	Cuts produce into uniform pieces before drying	Even thickness dries faster and better	Slice, dry and pack ginger, turmeric, banana or jackfruit
Pulveriser	Grinds dried produce into powder	Turns dried surplus into marketable product	Millet flour, moringa, curry leaf, turmeric, chilli and ginger powders, spice mixes

7.5 Case studies

Case 7.1 — Sunil Bhilare, strawberry farmer, Bhilar village, Satara, Maharashtra. Bhilar is 70–75 km from Pune, the main strawberry market. Strawberry is highly perishable, with a November–June season. He faced distant markets, no storage to pool harvests, frequent costly trips, low trader prices and high cold-store rents in peak season. He joined a PHLM awareness programme run by SELCO Foundation with KVK, BAIF and SMART that reached over 1,000 farmers; SELCO Foundation then did a baseline, recommended a cooling solution, assessed the business model and supported installation.



Figure 7.3 — Strawberries in crates inside the solar cold room



Figure 7.4 — Sunil Bhilare in the 10 MT solar cold room

TABLE 7.6

Sunil Bhilare — profile and impact

Dimension	Details
Technology	Solar-powered cold storage (single chamber), 10 MT, 7kWp solar energy capacity 4-20 degrees temperature (approx. 21-25 kWh power generation)
Business model; ownership	Trader model; individual
Cost of unit	₹1,395,000
Price realisation	20% higher
Markets	Hyderabad, Chennai, Bengaluru, Coimbatore, Trivandrum, Lucknow, Kochi and others
Harvest pooling	2–3 harvests pooled with quality maintained
Post-harvest loss	15–20% before; almost nil after
Utilisation	60–70%; plans to expand procurement
Wider effect	Neighbouring farmers get fair prices from his procurement

Nagaveni, Sapalamma Grama Lakshmi Streeshakti Sangha, Somenahalli village, Kolar, Karnataka.

Kolar is among the most drought-prone districts in the state. The 13-member SHG, formed in 2015, mostly grew tomato and potato as mono-crops and lost heavily in market gluts. Government departments introduced mushroom cultivation and processing to help them diversify. But the taluk market is over 40 km away and there was no cold storage, so over 40% of produce spoiled before sale. After a PHLM training by SELCO Foundation and the Collective Action Network (CAN), Nagaveni, who joined the SHG in 2018, led the group's adoption of a tunnel solar dryer.



Figure 7.5 — Inside the polycarbonate tunnel solar dryer



Figure 7.6 — Drying trays in the tunnel solar dryer, Somenahalli

TABLE 7.7

Case study Nagaveni — profile, financing and impact

Dimension	Details
Technology	500 kg polycarbonate tunnel solar dryer (30 trays; 120 W solar panel)
Produce	Mushroom, tomato, onion, moringa, mango
Business model; ownership	Hybrid (90% trader, 10% service); group-owned, run by the SHG
Cost of unit	₹367,000
Financing	PMFME subsidy plus Canara Bank loan of ₹2,10,000 at 11% over 5 years; EMI ₹4,566
Market linkages	Bulk orders from NRLM and district Horticulture and Agriculture departments; exhibitions and fairs via NRLM; buy-back agreement with a vendor for dried mushroom, tomato and moringa
Training	PHLM training by SELCO Foundation and CAN; operation and maintenance from technology provider; processing and value addition from IIHR, KVKs and GKVK
Post-harvest loss	Over 40% before; little or no spoilage after
Revenue	₹36,000 per month
Wider effect	SHG expanded mushroom cultivation; income diversified into processing

7.6 Replication and suitability

TABLE 7.8

Suitability by technology

Technology	Viability and suitable users
Cold rooms	Viable mainly with high-value crops, processing or enough aggregation. FPOs and FPCs: strongest case, from higher aggregation and utilisation. SHGs: shared use for aggregation or processing. Individuals: with high-value crops or for processing
Graders	Depends on grader type and crop. Fruit and vegetable graders suit SHGs, FPOs and FPCs, which have the volume to use them well

Technology	Viability and suitable users
Dryers	Suit SHGs and FPOs for value addition; individuals where there is steady seasonal or perishable supply and a market for dried products
Slicers	Suit SHGs and groups processing seasonal produce before drying
Pulverisers	Suit SHGs and FPOs moving from raw sales to flours and powders for local or institutional markets.

7.7 Scheme convergence

Post-harvest loss management can draw support from the schemes listed below.

TABLE 7.9

Scheme convergence: post-harvest loss management

Scheme	Relevance to this package	Key support
Agriculture Infrastructure Fund (AIF)	Cold storage, cold chain, packhouses, sorting, grading and primary processing; most useful where FPOs have the throughput to repay	3% interest subvention on loans up to ₹2 crore, for up to 7 years
Mission for Integrated Development of Horticulture (MIDH)	Cold rooms, pre-cooling units, cold storage, integrated cold chain	35% assistance for staging cold rooms and solar cold rooms in general areas (2025 guidelines), subject to cost norms
Prime Minister's Formalization of Micro Enterprises (PMFME)	Dryers	35% credit-linked capital subsidy, with remaining as a loan for 3-5 years (at 12-15% interest per annum)

PACKAGE 8

Sustainable Decentralised Processing Units

8.1 Overview and need

> Decentralised processing units are small or medium facilities where farmers can process their produce locally. They help make the produce ready for the market and let farmers sell more than just raw produce. In dry and arid regions, these units are useful because they:

- Reduce post-harvest losses by processing surplus or perishable produce.
- Earn more value where there is demand for processed products.
- Extend shelf life through drying, packaging and storage.
- Reduce the need to transport bulky or perishable raw produce.
- Create local jobs in processing, grading, packaging and marketing.
- Allow sales across different seasons and to different types of customers.

8.2 Services offered

The main functions of these units are cleaning and grading, drying and dehydration, value addition (such as powders, pickles and pastes), packaging and storage, and shared processing on common equipment. The units can also dry and process produce for other farmers for a fee, and supply pulp in bulk to food businesses. The key processing units and their uses are listed below.

TABLE 8.1

Key processing units and uses

Processing unit	Suitable commodities	Main purpose
Solar or mechanical dryer	Chilli, tomato, onion, mango	Reduces moisture; extends shelf life
Pulveriser or grinding unit	Chilli, turmeric, ginger, millets	Produces powders for sale
Washing, grading and sorting unit	Tomato, onion, mango and others	Improves quality and consistency
Pickle or paste unit	Mango, chilli, lemon, tomato	Converts fresh produce into value-added products
Oil extraction unit	Coconut and suitable oilseeds	Produces oil and by-products
Packaging and sealing unit	Dried produce, powders, pickles	Protects quality; prepares products for sale

8.3 Technologies

The steps from fresh produce to a market-ready product are:

1. **Harvest and collection:** Harvest the produce at the right maturity and move it quickly to the processing point.
2. **Sorting and grading:** Remove rotten, damaged or diseased produce, and grade the rest by size, maturity and quality.
3. **Washing and preparation:** Wash with clean water and follow food-safety practices suited to the crop.
4. **Processing, by one of two routes:** (A) slicing and solar drying, where uniform slices are dried in a single layer to the target moisture; or (B) pulp extraction, where the produce is peeled or de-seeded, pulped and strained.
5. **Finishing:** (A) mill the dried slices into flakes or powder and pack them in moisture-proof packs; or (B) preserve the pulp by a proven (validated) method, such as pasteurisation and hot filling, or freezing, and then pack it.
6. **Marketing and records:** Label each pack and give it a batch code. Keep records of input, output, losses, costs and sales.

Solar dryer. A solar dryer is a closed unit that uses the sun's heat to remove moisture. Compared with open sun drying, it protects the produce better from dust, insects and animals, and dries it more evenly. Drying time depends on sunlight, humidity, airflow, how thickly the produce is loaded and the type of produce. A hybrid dryer or backup heating helps when the weather is not reliable. Drying does not make spoiled produce safe, so sorting and hygiene are still essential.

Slicer. A slicer cuts produce into uniform pieces so that they dry evenly. This increases output, improves product quality and means more batches can be used. The practical sequence is: sort, wash, drain, peel if needed, slice, load without overcrowding, dry, cool, pack and store in a dry place.

Pulper. A pulper separates the edible pulp from the seeds, skins and fibres of fruit that is sound but soft, ripe or not good-looking enough to sell fresh. Preserved pulp lets processing continue beyond the peak harvest period, for use in beverages, jams, sauces, bakery fillings and institutional food. Pulp does not become shelf-stable just because it is packed; commercial processing must follow FSSAI requirements.

8.4 Business models

Decentralised processing units can be run in different ways. The main operating models and their benefits are compared below.

TABLE 8.2

Operating models for decentralised processing

Operating model	How it works	Potential benefits
FPO or farmer collective	Owns or manages a common facility; aggregates produce, schedules member batches, buys packaging in bulk, markets standard products	Shared capital and operating costs; larger volumes; stronger negotiation; consistent supply
SHG or women's group	Runs a small slicer, dryer, pulper or packaging line; divides preparation, processing, hygiene, records and sales	Local jobs, group income, enterprise skills, products from local crops
Individual farmer or micro-enterprise	Starts with one crop and one small technology; processes surplus that cannot sell fresh	Lower entry scale; less pressure to sell immediately; extra route to market

8.5 Case studies

Case 8.1 — Shivakumar, moringa value chain, Puttathimmanahalli, Chikkaballapur, Karnataka. He moved from chemical plantation farming to organic moringa on four acres after a three-month course at Organic Mandya. During gluts he sun-dried leaves, which dried unevenly and blew away and he paid to transport leaves elsewhere for powdering. The Chikkaballapur Agriculture Department referred him to SELCO Foundation, which assessed the site and recommended the technology.



Figure 8.1 — Produce drying on trays in the tunnel solar dryer



Figure 8.2 — Leaves drying in the tunnel solar dryer

TABLE 8.3

Case study: Shivakumar — profile, financing and impact

Dimension	Details
Technology	500 kg polycarbonate tunnel solar dryer (68 trays); 0.5 HP solar slicer; 2 HP solar pulveriser
Produce	Moringa, curry leaves, carrot, beetroot, tomato
Business model; ownership	Trader model, now hybrid; individual
Project cost	₹1,200,000
Financing	Union Bank of India loan ₹8,50,000 at 11% over 7 years; EMI ₹14,285 as reported (D-18)
Market linkages	Own brand Punarvi Naturals; Sriyutha Foods, Fruits & Roots, Nature Fresh Farms, Khadiya Food Tech; website and social media
Impact	Even drying, minimal wastage, higher-quality products; powder sold in gluts earns more than raw leaves

Dimension	Details
Diversification	Buys surplus tomato, carrot and beetroot in gluts; offers drying and processing services for a fee
Earnings from processing and services	Nearly ₹50,000 (period not stated, D-19)
Way forward	Farm in C1 organic conversion; full organic status expected in 2–3 years

500 kg tunnel solar dryer with slicer and pulveriser (Case 8.1)

This solar-powered drying and processing set-up is used for moringa, curry leaves, carrot, beetroot and tomato.

TABLE 8.4

500 kg tunnel solar dryer with slicer and pulveriser — specifications

Parameter	Specification
Dryer capacity	500 kg
Heating technology	Solar radiation
Dryer type	Solar-powered polycarbonate tunnel dryer
Dimensions	250+ sq ft (23 ft 6 in × 12 ft)
Number of trays	68
Slicer	0.5 HP, solar-powered
Pulveriser	2 HP, solar-powered
Project cost	₹1,200,000

8.6 Replication and suitability

TABLE 8.5

Suitability and Replication Potential: Solar Dryers and Processing Equipment

End-user group	Suitability	Replication potential
Individual farmers	HIGH	Can adopt small-scale solar dryers to reduce post-harvest losses, preserve surplus produce and process commodities for household use or local sale.
SHGs / Women-led groups	HIGH	Can operate community-level drying and processing units, producing dried fruits, vegetables and millet-based products for local markets.
FPOs / FPCs	HIGH	Can establish larger shared facilities to aggregate produce, undertake drying and processing, and develop value-added products for wider markets.
Farmer groups / FIGs	HIGH	Can collectively invest in dryers and share processing facilities, reducing individual investment costs and improving utilisation.
Rural agri-entrepreneurs	HIGH	Can establish fee-based drying and processing services for farmers and develop marketable finished products.

8.7 Scheme convergence

Decentralised processing units can draw support from two schemes: the Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME) and the Agriculture Infrastructure Fund (AIF). The support under each scheme is given below.

Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME)

TABLE 8.6

Scheme convergence: decentralised processing

Component	Support
Scheme and ministry	Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME), Ministry of Food Processing Industries
Objective	Strengthen micro food-processing enterprises through finance, technology upgrade, skills, common infrastructure and market access

Component	Support
Individual micro-enterprises	35% credit-linked capital subsidy, up to ₹10 lakh per unit
Common infrastructure	35% credit-linked capital subsidy, up to ₹3 crore, for eligible group projects
SHGs	Seed capital of ₹40,000 per eligible member for working capital and small tools
Branding and marketing	Up to 50% for eligible group-level initiatives
Target beneficiaries	Individual food-processing entrepreneurs, SHGs, FPOs/FPCs, eligible cooperatives

Agriculture Infrastructure Fund (AIF)

Nodal Department: Department of Agriculture & Farmers Welfare, Ministry of Agriculture & Farmers Welfare, Government of India

TABLE 8.7

Scheme convergence: Agriculture Infrastructure Fund (AIF)

Component	Support / Details
Objective	Mobilise medium- and long-term debt financing for developing post-harvest management infrastructure and community farming assets, improving storage, processing, value addition and farm-gate infrastructure.
Interest subvention	3% per annum on eligible loans up to ₹2 crore per project, for a maximum period of 7 years.
Projects above ₹2 crore	Loans may be considered, but interest subvention is restricted to the first ₹2 crore.
Credit guarantee	Credit guarantee support for eligible loans up to ₹2 crore through CGTMSE; FPOs may access applicable guarantee support through NABSanrakshan / FPO-related facilities.
Eligible infrastructure	Warehouses, cold storage and cold-chain facilities, grading and sorting units, assaying facilities, packaging units, primary processing, integrated primary and secondary processing
Target beneficiaries	Farmers, SHGs, FPOs/FPCs, PACS, cooperatives, agri-entrepreneurs, startups, JLGs and eligible public-private partnership projects.

PACKAGE 9

SHG/FPO Value Addition and Snack-Making Businesses

9.1 Overview and need

Food processing led by SHGs and FPOs helps reduce post-harvest losses and preserve seasonal produce through drying and value addition. Local groups can turn the crops available to them into snacks, flour mixes and speciality products, which last longer and fetch a better price. These enterprises also create livelihoods, especially for rural women, and help strengthen local market links and diversify income. These enterprises are relevant because they:

- Reduce losses by processing surplus or perishable produce before it spoils.
- Earn more from processed products than from raw produce.
- Create livelihoods for SHG members in production, packaging and sales.
- Build local businesses around the crops and traditional foods available in the area.
- Open up different markets, such as shops, institutions, fairs and direct sales.

9.2 Services offered

SHGs and FPOs can make a range of products with simple equipment, as listed below.

TABLE 9.1

Products and equipment

Product category	Examples	Typical equipment
Millet snacks	Roasted snacks, crackers, mixtures	Roaster, mixer, grinder, sealer
Fruit and vegetable snacks	Banana chips, dried tomato, vegetable chips	Slicer, dryer or fryer, packer
Pulse products	Roasted pulses, flour mixes	Roaster, pulveriser, mixer
Spice products	Chilli powder, spice mixes	Dryer, grinder, sifter, sealer
Traditional snacks	Murukku, chakli, papad	Dough mixer, shaping tools, fryer or dryer
Packaged snacks	Snack mixes, roasted products	Weighing scale, pouch sealer, labels

Local oil extraction: Small oil extraction units are suitable for individual farmers, SHGs and FPOs. Individual farmers can use small expellers or custom-processing services to make oil for their household and sell the surplus. SHGs can pool oilseeds from their members and manage processing, packaging and marketing together. FPOs can collect larger volumes, set up shared processing facilities and connect with retailers and bulk buyers. Before investing, a test batch should be run to check how much oil is recovered and whether the unit will be viable. Replication also needs good-quality seed, proper storage to prevent mould and rancidity, food-grade packaging and compliance with FSSAI requirements.

Papad-making: Papad-making is a good small-scale food processing enterprise for SHGs, especially groups led by women. The process includes buying ingredients, cleaning, weighing, preparing the flour, mixing the dough, dividing it into portions, pressing, drying hygienically, checking quality, packaging and marketing. The right equipment can reduce hard manual work while keeping traditional recipes and local tastes. When women are involved in choosing equipment, pricing, buying and sharing profits, it strengthens their financial independence, decision-making and leadership in the enterprise.



Figure 9.1 — Variety of papads

TABLE 9.2

Linking local seeds and papad-making in one enterprise

Local resource	Technology or process	Product or outcome
Suitable local oilseeds	Cleaning, grading, oil expeller	Edible oil and potentially useful press cake
Papad ingredients	Dough mixer, press or shaper, hygienic dryer, sealer	Consistent packaged traditional papad
Shared SHG/FPO services	Weighing, records, packaging, storage, sales	Better coordination; shared operating costs

9.3 Technologies

The solar-powered machines used to make chips are listed below.

TABLE 9.3

Solar powered chips-making machines

Machine	Operation
Potato peeler	Removes potato skin
Potato slicer	Slices the produce uniformly and facilitates easy drying
Banana slicer	Slices the produce uniformly and facilitates easy drying
Oil fryer	Cooks sliced potato or banana

Potato chips are made by peeling, slicing, cleaning and drying, frying and mixing in masala. Banana chips are made by peeling, slicing, frying and mixing in masala.

9.4 Business models

The potato chips unit is a solar-powered set-up with a slicer, peeler and dryer. It is financed with an 80% loan and 20% own contribution.

TABLE 9.4

Potato chips unit: investment and financing

Item	Amount	Note
Slicer (100 kg/hour)	₹41,300	17% of CAPEX
Peeler (120 kg/hour)	₹23,600	10% of CAPEX
Dryer (120 kg/hour)	₹21,140	9% of CAPEX
Solar power system	₹152,960	64% of CAPEX
Total capital cost	**₹239,000**	**100%**
Margin money (end user)	₹47,800	20% of CAPEX
Loan	₹191,200	80%; 11.5% p.a.; 60 months
EMI	₹4,205/month	₹50,460/year; total interest ₹61,099 over 5 years
Gap finance required	Nil	Profit covers EMI comfortably

TABLE 9.5

Potato chips unit: operations and unit economics

Line	Per month	Per year	Note
Raw potato processed	2,000 kg	24,000 kg	100 kg/day; 8 hours, 20 days/month
Chips produced	700 kg	8,400 kg	35 kg/day; 65% peel and moisture loss
Revenue (₹240/kg)	₹168,000	₹2,016,000	
Raw material	₹47,200	₹566,400	Potato, oil (200 kg/month), salt, chilli powder

Line	Per month	Per year	Note
Packaging	₹10,500	₹126,000	
Labour	₹4,000	₹48,000	To confirm (D-22)
Fuel	₹4,000	₹48,000	
Electricity	₹1,500	₹18,000	
Total operating cost	**₹67,200**	**₹806,400**	**40% of revenue**
Operating profit (before EMI)	₹100,800	₹1,209,600	60% margin
Net profit after EMI	**₹96,595**	**₹1,159,140**	**57% margin**
Breakeven	248 kg (₹59,452)		35% of planned output
Payback	About 6 months (0.49 years)		Assumes 40% of operating profit goes to repayment

9.5 Case studies

Case 9.1 — Mr. Muniraju, chips maker, Konaghatta, Doddaballapur, Bengaluru.

In the chips business for 15 years and sole earner for a family of nine, he faced long hours, injuries from manual cutting and peeling, irregular power, rising electricity bills and low productivity. In 2019, SELCO Foundation supported a solar module and a 0.5 HP DC slicer.

TABLE 9.6

Case study: Muniraju — outcomes

Indicator	Outcome
Banana chips production	100–150 kg/hour
Potato chips production	150–200 kg/hour
Daily production	More than 300 kg in 10 hours
Energy access	Less dependence on unreliable grid power
Labour and health	Less manual effort and strain
Business impact	Higher income and production



Figure 9.2 — Muniraju and family, Konaghatta



Figure 9.3 — Potato and banana chips

Case 9.2 — Chikkamma Kumar, papad enterprise, Tumkur, Karnataka. A home-based business selling under the KMB brand to market vendors. The family worked about 12 hours a day and hired extra workers; after an accident five years earlier, Chikkamma could not do labour-intensive work.

SELCO Foundation supported a solar-powered hydraulic papad machine so she could restart production independently.

TABLE 9.7

Case study: Chikkamma Kumar — outcomes

Impact area	Outcome
Production	375 kg of papad per month
Revenue	₹56,000 (period to confirm, D-23)
Net income	₹32,000 (period to confirm, D-23)
Productivity	Threefold increase in production and income
Workload	Less physical effort, time and cost; works independently
Market access	KMB brand to market vendors; also sells coffee powder and fryums



Figure 9.4 — Chikkamma Kumar with her solar hydraulic papad machine



Figure 9.5 — Packed papad ready for sale



Figure 9.6 — Papad drying

9.6 Replication and suitability

TABLE 9.8

Suitability and Replication Potential

End-user typology	Suitability	Rationale
Individual farmers	HIGH	Can utilise locally available raw materials to produce value-added products for household use or local sale.
Home-based entrepreneurs	HIGH	Can establish small-scale processing units with relatively localised operations, including in remote areas.
SHGs / Women-led groups	HIGH	Can collectively manage production, processing, packaging and marketing as a livelihood enterprise.
FPOs / FPCs	HIGH	Can aggregate raw materials, operate shared processing facilities and connect products to wider markets.

9.7 Scheme convergence

SHG and FPO food processing units can draw support from PMFME, as shown below.

TABLE 9.9

Scheme convergence: PMFME

Component	Support
Scheme and ministry	Pradhan Mantri Formalisation of Micro Food Processing Enterprises (PMFME), Ministry of Food Processing Industries
Objective	Strengthen micro food-processing enterprises through finance, technology upgrade, skills, common infrastructure and market access

Component	Support
Individual micro-enterprises	35% credit-linked capital subsidy, up to ₹10 lakh per unit
Common infrastructure	35% credit-linked capital subsidy, up to ₹3 crore, for eligible group projects
SHGs	Seed capital of ₹40,000 per eligible member for working capital and small tools
Branding and marketing	Up to 50% for eligible group-level initiatives
Target beneficiaries	Individual food-processing entrepreneurs, SHGs, FPOs/FPCs, eligible cooperatives

SECTION 10

Conclusion

The nine solution packages presented in this compendium demonstrate how decentralised renewable energy (DRE)-enabled technologies, when integrated with sustainable agricultural practices, can address challenges across different stages of the agricultural value chain. From strengthening access to indigenous seeds and locally produced bio-inputs to improving soil health, enabling precision farming, supporting efficient irrigation and reducing post-harvest losses, the packages offer practical approaches to improving farm productivity, resource efficiency and livelihood opportunities.

The field experiences documented in the compendium highlight the potential of these solutions when they are aligned with the needs and capacities of end users. Community seed banks have demonstrated how farmer-led institutions can conserve indigenous varieties while creating opportunities for seed multiplication and distribution. Bio-resource centres and decentralised bio-input units show how locally available agricultural residues and organic resources can be converted into useful farm inputs. Similarly, interventions such as zero-tillage equipment, solar-powered irrigation and IoT-based monitoring provide opportunities to reduce labour requirements, improve water-use efficiency and support more informed farm-level decisions. On the post-harvest side, solar dryers, cold storage and decentralised processing units enable farmers and collectives to preserve produce, minimise losses, improve product quality and explore value-addition opportunities.

The case studies also demonstrate that the viability and sustainability of these interventions depend on more than technology installation. Appropriate ownership structures, regular utilisation, local resource availability, operational capacities, market linkages and access to suitable financing are important considerations. SHGs, FPOs/FPCs, farmer groups, individual entrepreneurs and community institutions can play different roles in owning and managing these solutions, depending on the scale of investment and nature of operations. Convergence with relevant government schemes and financial institutions can further support adoption and replication.

This compendium therefore serves as a practical reference for identifying suitable technology and practice combinations, assessing investment and operational requirements, and understanding potential business models for different end-user groups. The cost estimates, technical specifications and financial projections should be validated against local conditions before implementation. Ultimately, the focus should be on enabling solutions that are technically appropriate, financially viable and locally manageable, ensuring that small and marginal farmers, women-led enterprises and farmer collectives can access and sustain these interventions across agricultural value chains.



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