KVA Consult Ltd

Pacific Horticultural & Agricultural Market Access Plus Program

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Business Case: Solar Dryers for Kava Processing in Samoa

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Business Case: Solar Dryers for Kava Processing in Samoa

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Disclaimer: This business case is based on data from existing solar dryer installations and pilot farmer interviews conducted August-September 2025. Financial projections represent reasonable estimates based on farmer feedback. Actual results may vary depending on individual circumstances, management practices, market conditions, and other factors. Farmers should conduct due diligence and seek professional advice before investment decisions.

Executive Summary

This business case provides an analysis of tunnel-style solar dryers for agricultural post-harvest processing in Samoa, designed to help farmers, MSMEs, commercial lenders, and development partners make informed investment decisions regarding solar dryer technology deployment under commercial financing conditions.

The analysis draws on operational data from pilot solar dryers installed for kava production under the PHAMA Plus program, supplemented by supplier quotations (May 2025) and commercial lending consultations with Development Bank of Samoa and Samoa Commercial Bank. **The pilot was financed 100% through PHAMA Plus grant funding**; however, this business case models financial performance under commercial bank financing scenarios to assess technology viability for market- based replication.

Key Findings

The financial analysis reveals strong investment returns across all solar dryer configurations when modeled under commercial bank financing terms (100% debt at 14% interest, 3-year term). The smallest configuration (5×6 m) requires WST 14,300 capital and shows modeled 120% annual returns with 9-month payback and 1.98× debt service coverage. The pilot-validated 15×6 m configuration requires WST 22,045 and demonstrates modeled 146% returns with 8.5-month payback and 2.28× debt coverage. The 10×6 m configuration (WST 19,700) projects 135% returns with 9-month payback and 2.13× coverage. The largest export-scale 30×6 m configuration (WST 34,342) shows modeled 155% returns with 7.5-month payback and 2.52× coverage. All configurations generate positive cash flow from Month 1 with debt service coverage ratios substantially exceeding commercial lending thresholds (typically 1.25×-1.35×).

The 15×6 m pilot installation achieved 46% Earnings Before Interest, Taxes, Depreciation, and Amortization (EBITDA) margins at 50% capacity utilization under grant funding. Pilot farmers demonstrate operational viability, including up to 300% weekly revenue increases and multi-crop utilisation. Kava market conditions support commercial deployment with stable pricing (WST 8-10 per packet), consistent demand exceeding supply, and emerging export opportunities in Fiji, United States, and Australia. **However, these are modeled projections based on grant-funded operations; actual commercial deployment requires validation through real-world lending programs.**

Recommendations

For Farmers and Processors: Solar dryers demonstrate strong operational profitability (41-51% EBITDA margins) based on pilot performance. However, transition from grant-funded to commercially-financed deployment requires careful assessment of debt service capacity. Operators should evaluate whether their financial management capability matches operational skills before accessing commercial loans. Micro-enterprises should seek microfinance with Samoa Business Hub guarantees or blended finance; small processors should access Development Bank of Samoa concessional lending (6-10% vs. 12-14% commercial rates); commercial SMEs can pursue standard bank loans; export-scale processors can access commercial or institutional financing. Multi-crop utilization improves revenue stability and debt coverage.

For MSMEs and Commercial Processors: The 15×6 m and 30×6 m configurations demonstrate modeled commercial viability suitable for business expansion planning. Integration with complementary processing equipment, such as pounding machines, storage facilities and packaging equipment, completes value chains for export market entry. Financial projections require validation through actual commercial operations before large-scale investment commitments.

For Commercial Lenders and Development Banks: Solar dryers demonstrate exceptional modeled economics (120-155% ROI, 28-36% IRR, 1.98×-2.52× DSCR) based on grant-funded pilot operations. Recommended approach: pilot lending programs with close monitoring to validate financial assumptions, potentially with Samoa Business Hub guarantee mechanisms (up to 100% coverage) or Development Bank of Samoa concessional facilities to de-risk first commercial deployments. Loan products should feature 3-5 year terms with seasonal payment flexibility aligned to harvest cycles.

For Government and Development Partners: The pilot successfully demonstrated operational viability under grant financing. Transition to commercial sustainability requires: pilot commercial lending programs to validate modeled debt service capacity; development of standardized lending assessment tools adapted to solar dryer economics; technical assistance programs supporting borrower financial management capacity; Samoa Business Hub guarantee coverage extension and Development Bank of Samoa dedicated credit lines; and quality certification systems supporting export market access. The technology demonstrates clear potential for scaled deployment beyond grant dependency, but requires structured transition support with monitoring frameworks validating modeled projections.

Section 1. Introduction and Context

1.1 About PHAMA Plus

The Pacific Horticultural and Agricultural Market Access Plus Programme is a joint Australian and New Zealand government initiative supporting inclusive economic growth and improved livelihoods for Pacific people, prioritising gender equality, inclusion, and climate resilience. Since 2011, PHAMA Plus has worked with Pacific businesses, industry groups, and government partners to maintain and improve agricultural trade by helping participants adopt innovations, improve practices, and meet export requirements. In Samoa, the programme supports root crops, ornamentals, kava, and biosecurity, with kava activities focused on improving farmers' processing capacities to enhance product quality and quantity.

1.2 Solar Dryer Pilot in Savaii

PHAMA Plus has introduced tunnel-design solar dryers for five kava farmers in Savaii, fundamentally changing kava and other agricultural product drying for programme beneficiaries. The pilot installations demonstrate faster drying times of 2 to 3 days compared to traditional open-air sun drying of 4 to 6 days, with weather-independent operations eliminating production delays during Samoa's rainy season when traditional methods can extend drying times to 10 days or more. Product quality has also improved markedly through elimination of contamination from dust, insects, and animals, while labour requirements have decreased substantially and production capacity has increased by a factor of two to three. The success of these pilot installations has generated significant interest from farmers across both Savaii and Upolu, and this business case evaluates the investment requirements and benefits to guide farmer decision-making and business planning as the technology expands beyond the initial pilot group.

1.3 The Kava Drying Challenge

Traditional open-air sun drying creates significant challenges for Samoa's kava farmers, with drying times of 4 to 6 days under optimal conditions extending to 7 to 10 days during the rainy season, constraining harvest volumes and forcing farmers to leave mature kava in the ground beyond optimal harvest dates. The labour-intensive process of daily spreading, turning, and covering diverts time from other productive farm activities, while contamination from dust, insects, and animals, variable moisture content, and product losses of 10 to 15 percent from weather damage and spoilage prevent farmers from meeting export quality standards.

These constraints create substantial economic impacts, with volatile revenue during rainy seasons, high opportunity costs from labour devoted to drying management, and inability to respond to market demand spikes, while lower prices for inconsistent quality further erode income. Solar dryers directly address these constraints by providing a controlled, weather-independent drying environment that removes the primary bottleneck in the kava production system.

1.4 Purpose and Scope of This Business Case

This business case provides evidence-based analysis to support multiple stakeholder groups making decisions about solar dryer technology deployment in Samoa's agricultural sector. For farmers and processors, it offers the financial and operational information needed for investment decisions. For commercial lenders and development banks, it presents the risk and return analysis required for financing decisions under market-based lending terms. For government agencies and development partners, it informs policy and programme design for transitioning from grant-dependent pilot implementations to commercially sustainable scaled deployment.

The analysis covers detailed financial modeling across four solar dryer configurations (5×6 m, 10×6 m, 15×6 m, and 30×6 m) with the 15×6 m pilot installation providing the empirical foundation for all

projections. It is critical to note for this analysis, that the pilot dryer was financed 100% through PHAMA Plus grant funding; whereas, this business case models financial performance under commercial bank financing scenarios (100% debt at 14% interest, representative of current SME lending rates). This approach demonstrates whether the operational margins and cash flows achieved during the grant-funded pilot would be sufficient to support commercial financing, thereby establishing a pathway for market-based replication without ongoing donor subsidy.

The methodology draws from multiple validated sources: pilot data collected during consultations; quotations for capital costs; Development Bank of Samoa and Samoa Commercial Bank consultations confirming commercial lending parameters; market pricing surveys and pilot sales data with selected supermarkets; and financial modeling using cost- benefit analysis, IRR calculations, debt service coverage projections, and sensitivity testing. The financial projections represent modeled commercial scenarios based on pilot operational performance and require real-world validation through commercial lending programs.

Section 2. Solar Dryer Technology Description

2.1 What Is a Tunnel-Style Solar Dryer?

A tunnel-style solar dryer is a greenhouse-like structure specifically engineered for drying agricultural products using solar energy. The design consists of several integrated components working together to create an optimal drying environment.

The structural frame uses galvanized steel posts of 25mm diameter formed into an arched tunnel configuration. This galvanized construction provides durability while resisting the corrosion that would quickly degrade standard steel in Samoa's humid tropical climate. The arched design maximizes interior volume while providing structural strength against wind loads.

UV-stabilized plastic film at 0.12mm thickness covers the frame, creating a transparent envelope that allows solar radiation to enter while protecting the product from rain. This film has been specifically formulated to withstand tropical sun exposure without rapid degradation, a critical feature given the intensity of solar radiation in Samoa.

Inside the structure, elevated drying tables constructed from hot-dip galvanized steel mesh provide the surface where agricultural products are spread for drying. These tables typically measure 2.0 meters by 1.2 meters with a height of 0.9 meters above ground level. The elevation prevents ground contamination while the mesh construction allows air circulation around all surfaces of the drying product.

An adjustable ventilation system using side panels enables farmers to control both temperature and humidity within the structure. This control capability allows optimization of drying conditions for different crops and adjustment in response to varying ambient weather conditions. Optional floor gravel serves dual purposes, improving drainage around the structure while providing thermal mass that moderates temperature fluctuations.

2.2 How Solar Dryers Work

The operating principle is straightforward but effective. Solar radiation passes through the transparent plastic film and heats the interior air. This enclosed greenhouse effect raises interior temperatures 5 to 15 degrees Celsius above ambient conditions, significantly accelerating moisture evaporation from the product being dried.

As moisture evaporates from the product, it increases the humidity of the interior air. This hot, humid air becomes less dense than the surrounding cooler air and naturally rises, exiting through the ventilation openings at the top of the structure. Fresh, drier air enters through lower openings, establishing a continuous air circulation pattern that carries moisture away from the drying product.

The enclosed structure provides complete protection from rain, allowing drying to continue even during Samoa's frequent precipitation events. Protection from dust, insects, and animals occurs simultaneously, addressing multiple quality concerns with a single infrastructure investment. The controlled environment created by this design produces uniform moisture content across batches and within individual batches.

2.3 Available Sizes and Capacity

Solar dryers are available in five standard sizes designed to match different farm scales and production volumes. The following table summarizes the available options:

Table 1. Available Solar Dryer Sizes, Area, Capacity and Cost

Size	Drying Area	Annual Capacity (dried kava)	Investment Cost (WST)
5×6m	30 m^2	~1,000 kg	10,300
10×6m	60 m^2	~1,500 kg	18,200
15×6m	90 m^2	~2,500 kg	20,600
20×6m	120 m^2	~3,500 kg	25,200
30×6m	180 m^2	~5,000 kg	34,300

These capacity calculations assume that each square meter of drying area processes 5 to 7 kilograms of dried product per batch, with a typical batch cycle of 2.5 days. Annual capacity projections assume approximately 100 to 120 drying cycles per year, representing nearly continuous operation. The estimates are deliberately conservative; actual performance may exceed these projections under optimal management. Complete specifications for all sizes are provided in **Appendix B**.

2.4 Key Benefits

<table>
<tr>
<td>Production Benefits
● Drying time reduced by 25 to 50 percent, enabling more product processing without expanding cultivation area
● Weather independence eliminates revenue volatility during rainy seasons
● Production capacity increases by two to three times, enabling response to previously unreachable market opportunities
● Consistent quality builds customer confidence and supports premium pricing</td>
<td>Economic Benefits
● Annual returns of 120-155% depending on dryer scale, with rapid payback periods of 7.5-9 months
● Product loss reduced from 8-15 percent (traditional sun drying) to 1-2 percent (solar dryer), protecting revenue
● Consistent quality enables access to premium domestic markets and emerging export opportunities (Fiji, United States, Australia)</td>
</tr>
<tr>
<td>Operational Benefits
● Labour requirements decrease by 60 percent, transforming drying from a daily task to a load- and-unload operation
● Weather monitoring becomes unnecessary with enclosed structures
● Technology scales effectively without proportional labour increases</td>
<td>Environmental Benefits
● Solar-powered system generates low to zero emissions
● Weather-protected infrastructure provides climate-resilient development
● Productivity increases without requiring land expansion into forest areas</td>
</tr>
</table>

2.5 Equipment Durability and Maintenance

The overall structure, when properly maintained, delivers 10 to 15 years of productive service. This equipment life provides the foundation for the financial analysis presented later in this document. The plastic film covering requires replacement every 3 to 5 years as UV exposure gradually degrades the material despite its stabilized formulation. The steel frame and drying tables, benefiting from galvanization, also last 10 to 15 years under Samoan conditions. Maintenance requirements are modest, as summarized in the following table:

Table 2. Maintenance Requirements for Solar Dryers

Frequency	Tasks	Time Required	Typical Costs (WST)
Monthly	Clean film, visual inspection, check connections, ensure drainage	1-2 hours	20-50
Annually	Detailed post-cyclone inspection, minor repairs, rust treatment	3-4 hours	150-250
Every 3-5 years	Film replacement	4-6 hours	800-1,500

Monthly tasks consuming only 1 to 2 hours include cleaning the plastic film to maintain transparency, conducting visual inspection for tears or damage, checking structural connections for loosening, and ensuring that drainage systems function properly. Annual maintenance includes detailed inspection following the rainy/cyclone season, minor repairs such as patching tears and tightening connections, and rust treatment if any corrosion spots appear despite galvanization.

Farmer experience confirms the reliability of projections, with reports that after more than two years of operations there has been no challenges or problems with the equipment. The systems have operated smoothly through all seasons with only the minimal maintenance needs of occasional cleaning and checking connections after cyclones.

2.6 Complementary Equipment

While the solar dryer removes the primary bottleneck in kava processing, maximum value capture requires additional equipment investments. The following table outlines recommended complementary equipment:

Table 3. Complimentary Equipment for Kava Production

Equipment Type	Function	Investment Range (WST)	When to Add
Pounding/grinding machine	Converts dried chips to export-ready powder	5,000-15,000	Year 2, when producing 50+ kg weekly
Packaging equipment	Professional presentation (scales, sealers, labels)	500-2,000	Year 3, for branding
Storage facilities	Weather-protected storage for dried product	2,000-5,000	Ongoing, can adapt existing structures

Section 3. Financial Analysis Summary

This section presents the financial performance assessment of four solar-dryer configurations, 5×6 m, 10×6 m, 15×6 m, and 30×6 m, modeled under commercial financing scenarios to evaluate bankability and investment viability for future replication.

The 15×6 m configuration serves as the reference model for this analysis, with operational data collected from the pilot installation over the 2024-2025 period. The pilot dryer was financed 100% through grant funds provided by the PHAMA Plus program; however, this analysis models the financial performance under commercial bank financing terms to assess the technology's viability for market-based replication without ongoing donor subsidy.

Smaller (5×6 m, 10×6 m) and larger (30×6 m) configurations have been modeled using proportional scaling factors derived from the pilot data and confirmed supplier pricing (May 2025). All configurations are assessed under standardized commercial financing parameters: 50% capacity utilization, 100% debt financing at 14% interest rate (representative of average unsecured commercial SME lending rates in Samoa), and tax-exempt agricultural enterprise status.

This financial modeling demonstrates whether solar dryers can operate as commercially viable enterprises when financed through standard banking channels, thereby establishing a pathway for scaled deployment beyond grant-dependent implementation models. The analysis provides evidence for lenders, investors, and policymakers regarding the technology's bankability and return potential under market conditions.

3.1 Capital Investment Requirements

Solar dryer capital costs demonstrate linear scaling characteristics based on structural dimensions and component quantities. The 15×6 m pilot installation provides baseline costing, with proportional adjustments for alternative configurations.

Table 4. Capital Investment Profile by Configuration

Dryer Size	Installed Cost	Unit Cost (per m^2)	Scaling Factor (vs. 15×6 m)	Target Market Segment
5 × 6 m	WST 14,300	WST 477	0.65×	Micro-enterprise / pilot implementation
10 × 6 m	WST 19,700	WST 328	0.89×	SME sector / cooperative structures
15 × 6 m	WST 22,045	WST 245	1.00× (Reference Model)	Commercial operations (pilot validated)
30 × 6 m	WST 34,342	WST 191	1.56×	Export-oriented / institutional investor

Capital costs include: prefabricated frame, UV-stabilized film, drying trays, fixtures, freight, site preparation, and commissioning. Costs verified through quotation dated May 2025. The pilot 15×6 m unit was financed entirely through PHAMA Plus grant funding; figures shown represent actual procurement costs for commercial replication scenarios.

Scale Economics

Unit costs decline from WST 477/m^2 (5×6 m) to WST 191/m^2 (30×6 m), representing a 60% reduction in capital intensity across the configuration range. This cost structure reflects economies of scale in structural materials and fixed installation components (foundation work, door systems, ventilation features) which remain relatively constant regardless of total surface area.

The maximum capital requirement of WST 34,342 (30×6 m configuration) represents approximately 40-45% of comparable imported mechanical drying systems (indicative market price: WST 75,000- 85,000), based on informal supplier consultations conducted during the pilot phase.

Comparative Costing Analysis: Prefabricated vs. DIY Construction

A comparative cost assessment was conducted to establish the price differential between turnkey solar dryer packages and locally-sourced DIY construction alternatives. Local suppliers in Apia provide tunnel-house kits suitable for agricultural applications; provides tunnel-house kits suitable for agricultural applications; however, these require significant additional investment to achieve functional food-processing capacity.

Table 5. Cost Comparison Analysis (15×6 m Equivalent)

Cost Component	DIY Approach	Turnkey Package (Pilot)	Variance	Notes
Frame and covering kit	WST 8,791	Integrated	-	Basic tunnel house structure only
Drying trays (36 units)	WST 8,100	Integrated	-	Custom fabrication required
Installation labor	WST 2,000-3,000	Integrated	-	Farmer-arranged
Transport to site	WST 500-1,500	Integrated	-	Location-dependent
Site preparation	WST 1,000-2,000	Integrated	-	Ground leveling, drainage
Total System Cost	WST 20,391-23,391	WST 22,045	WST (1,654) - 1,346	Complete functional comparison
Implementation timeline	80-120 hours	2-3 days	75-115 hours	Owner labor time
Technical warranty	None (self-build)	12 months	Risk transfer	Manufacturer warranty coverage
Design optimization	Generalist structure	Purpose-engineered	Performance gap	Horticultural vs. food-processing

Observations

When all inputs are considered, the DIY system—though initially priced at WST 8,791 for the frame kit—ends up costing between WST 20,391 and 23,391 once trays, labor, transport, and site preparation are included, compared to WST 22,045 for the turnkey package. This results in a variance of –WST 1,654 to +1,346, meaning the DIY option can be up to 6% more expensive overall. The DIY approach requires adaptation of horticultural infrastructure for food-processing applications, introducing technical variability and implementation risk.

The turnkey approach provides standardized specifications, warranty coverage, and proven performance parameters verified through the 15×6 m pilot installation. DIY construction may remain appropriate for owner-operator scenarios where labor opportunity costs are externalized and technical risk tolerance is higher. However, for commercial bank financing purposes, the standardized turnkey approach provides clearer collateral valuation and risk assessment parameters.

3.2 Operating Cost Structure

Operating cost projections are derived from data collected from farmers who received the grant- funded 15×6 m pilots and scaled proportionally for alternative configurations. While the pilot did not carry debt service obligations, operating cost data remains valid for commercial modeling as these expenses are independent of financing structure.

Operational Parameters

- Capacity utilization: 50% annual average (based on 12-month pilot observation including seasonal variability, maintenance downtime, and market absorption constraints)
- Labor requirements: Two operators per dryer at WST 5.00/hour (based on Samoa minimum wage compliance)
- Maintenance provision: 4% of CAPEX annually (pilot data: WST 882 average annual maintenance expenditure for 15×6 m unit)
- Depreciation schedule: 10-year straight-line (conservative assumption; manufacturer specifies 15-year design life)
- Variable costs: Packaging materials and transport allocated at 15% of gross revenue (pilot average: 14.7%)

Energy Cost Profile

Solar thermal operation eliminates fuel and electricity expenditure. Pilot monitoring recorded zero energy costs over a 12-month operational period, providing complete insulation from petroleum price volatility and grid electricity tariff adjustments.

3.3 Revenue Performance and Operating Margins

Revenue and margin projections are based on pilot sales data (15×6 m unit) operating at documented 50% capacity utilization, with proportional adjustments for alternative configurations based on verified drying capacity per square meter. Revenue figures represent market performance achieved during the grant-funded pilot phase and are applied to commercial financing scenarios.

Table 6. Operating Performance Summary (50% Utilization Scenario)

Dryer Size	Annual Revenue	Total Operating Costs	EBITDA	EBITDA Margin	Data Source
5 × 6 m	WST 52,000	WST 30,500	WST 21,500	41.3%	Scaled from pilot (0.67× capacity)
10 × 6 m	WST 65,000	WST 36,800	WST 28,200	43.4%	Scaled from pilot (0.83× capacity)
15 × 6 m	WST 78,000	WST 42,100	WST 35,900	46.0%	Pilot actual performance
30 × 6 m	WST 130,000	WST 63,400	WST 66,600	51.2%	Scaled from pilot (1.67× capacity)

EBITDA (Earnings Before Interest, Taxes, Depreciation, and Amortization) calculations exclude depreciation and interest expenses; margins calculated on gross revenue. Pilot achieved these margins under grant financing; margins would remain identical under commercial financing as operating costs are independent of capital structure.

Margin Analysis

EBITDA margins range from 41.3% (5×6 m) to 51.2% (30×6 m), reflecting operational leverage as fixed costs (labor, packaging infrastructure, maintenance overhead) are distributed across larger production volumes. The 15×6 m pilot achieved 46.0% EBITDA margin over the measurement period, providing empirical validation for the scaling assumptions applied to alternative configurations.

The pilot recorded monthly margin variability between 38% (low season) and 52% (peak production periods), with the 46.0% figure representing the 12-month weighted average. These margins demonstrate the operational profitability achievable before debt service obligations, establishing the baseline cash-generation capacity available to service commercial loans in replication scenarios.

3.4 Cash Flow and Debt Service Coverage Analysis

This subsection models cash flow performance and debt service capacity under hypothetical commercial financing scenarios. The 15×6 m pilot unit was financed entirely through PHAMA Plus grant funding and therefore carried no debt service obligations. The following analysis projects what debt service coverage would have been achieved had the pilot been financed through commercial bank lending at market rates.

Modeling Parameters

Debt service calculations assume 100% debt financing of capital costs at 14% annual interest rate (as noted during consultations with commercial banks in Samoa). Loan term assumed at 3 years with monthly installments, consistent with typical SME working capital and equipment financing structures.

Table 7. Modeled Debt Service Coverage Analysis

Dryer Size	Annual Debt Service (Modeled)	Free Cash Flow (Year 1)	Capital Recovery Period	DSCR	Financing Scenario
5 × 6 m	WST 5,400	WST 9,700	9.0 months	1.98×	Commercial financing model
10 × 6 m	WST 6,700	WST 12,900	9.0 months	2.13×	Commercial financing model
15 × 6 m	WST 8,400	WST 18,800	8.5 months	2.28×	Commercial financing model (pilot baseline)
30 × 6 m	WST 13,200	WST 33,400	7.5 months	2.52×	Commercial financing model

DSCR = Debt Service Coverage Ratio, calculated as Operating Cash Flow divided by Total Debt Service. These are modeled projections based on pilot operating performance; actual pilot carried no debt as it was 100% grant-funded.

Debt Service Methodology

The 15×6 m pilot generated WST 18,800 in free cash flow during Year 1 of operation (actual recorded performance under grant financing). Under a modeled commercial financing scenario with 100% debt at 14% interest, annual debt service would have been WST 8,400, resulting in a projected DSCR of 2.28×. This metric indicates that operating cash flow would have exceeded hypothetical debt service obligations by 128%, providing a substantial buffer against revenue shortfalls or cost escalation. Alternative configurations apply the same operational margin structure observed in the pilot, adjusted for scale-based cost efficiencies (larger units) or diseconomies (smaller units). Modeled capital recovery periods range from 7.5 to 9.0 months across the configuration spectrum, suggesting rapid payback potential under commercial financing arrangements.

These projections demonstrate that the operating margins achieved during the grant-funded pilot phase would be sufficient to support commercial bank financing. The DSCR values (1.98× to 2.52×) substantially exceed typical commercial lending requirements (1.25×-1.35× for Pacific SME facilities), indicating strong theoretical bankability. However, actual commercial deployment would require validation through real-world financed operations to confirm these projections and assess borrower capacity for debt management alongside operational responsibilities.

3.5 Investment Return Metrics

Return calculations model investment performance under commercial financing scenarios, using pilot-derived operating parameters and verified capital costs. **The pilot installation itself was grant- funded and therefore did not generate returns to investors**; however, the operational and revenue data enable modeling of hypothetical investor returns under market-based financing.

Table 8. Modeled Investment Performance Metrics (10-Year Analysis Period)

Financial Metric	5×6 m	10×6 m	15×6 m (Pilot Baseline)	30×6 m	Methodology
Capital Requirement	WST 14,300	WST 19,700	WST 22,045	WST 34,342	Turnkey quotation (May 2025)
Return on Investment (p.a.)	120%	135%	146%	155%	Modeled: Year 1 net income / capital
Net Profit Margin	39%	41%	43%	51%	Net income / gross revenue
Internal Rate of Return	28%	31%	32%	36%	NPV methodology, 10- year cash flows
Benefit-Cost Ratio	2.6:1	3.0:1	3.2:1	3.8:1	PV benefits / PV costs (10 years)
Payback Period	9.0 months	9.0 months	8.5 months	7.5 months	Cumulative cash flow analysis
DSCR (Year 1)	1.98×	2.13×	2.28×	2.52×	Operating cash flow / debt service

All return metrics represent modeled commercial financing scenarios. The actual pilot was 100% grant-funded by PHAMA Plus. Calculations use pilot operational performance (15×6 m) as baseline with proportional scaling for alternative configurations.

The 15×6 m pilot achieved operational performance that would theoretically generate 32% IRR over a 10-year period under commercial financing, with 146% annual ROI in Year 1. **These metrics represent what would have been achieved had the pilot been commercially financed rather than grant-funded**, providing evidence of potential commercial viability for future replication.

3.6 Scale-Based Performance Analysis

Financial performance indicators demonstrate systematic variation across the configuration range, with larger units exhibiting progressively stronger metrics across all categories. These projections model commercial financing scenarios based on pilot operational data.

Table 9. Comparative Performance Matrix (Commercial Financing Model)

Parameter	5×6 m	10×6 m	15×6 m (Pilot Baseline)	30×6 m	Variance Range
Capital Intensity	WST 477/m²	WST 328/m²	**WST 245/m²**	WST 191/m²	60% reduction
EBITDA Margin	41.3%	43.4%	**46.0%**	51.2%	+9.9 percentage points
Annual ROI (modeled)	120%	135%	**146%**	155%	+35 percentage points
IRR (10-year, modeled)	28%	31%	**32%**	36%	+8 percentage points
Payback Period (modeled)	9.0 months	9.0 months	**8.5 months**	7.5 months	1.5 months
DSCR (modeled)	1.98×	2.13×	**2.28×**	2.52×	0.54× improvement
Benefit-Cost Ratio	2.6:1	3.0:1	**3.2:1**	3.8:1	1.2:1 improvement

ROI, IRR, Payback, and DSCR figures represent modeled commercial financing scenarios; pilot was grant-funded. EBITDA margins reflect actual pilot operating performance.

All financial indicators demonstrate positive correlation with configuration size. Capital intensity (cost per m^2) decreases by 60% from smallest to largest configuration, while profitability metrics (margins, ROI, IRR) increase systematically under modeled commercial financing. This pattern reflects operational leverage characteristics wherein fixed costs (labor, maintenance, packaging setup) are distributed across progressively larger production volumes.

The 15×6 m pilot model occupies the mid-point of the performance spectrum, with actual operating margins of 46.0% translating to modeled commercial returns of 146% ROI and 32% IRR under hypothetical debt financing. Smaller configurations (5×6 m, 10×6 m) exhibit lower modeled returns

but maintain positive performance across all metrics. The 30×6 m configuration demonstrates the strongest modeled financial performance profile but requires 56% additional capital investment relative to the pilot model.

3.7 Investment Attribute Assessment

Solar dryer configurations demonstrate specific financial and operational characteristics relevant to investment evaluation and program design under commercial financing frameworks. The pilot provided empirical validation of operational parameters; commercial bankability requires validation through market-based financing.

Table 10. Investment Characteristics by Configuration (Commercial Financing Context)

Investment Attribute	5×6 m	10×6 m	15×6 m (Pilot Baseline)	30×6 m
Capital Range	Entry-level (WST 14,300)	Moderate (WST 19,700)	Standard (WST 22,045)	High (WST 34,342)
Modeled Debt Service	WST 5,400/year	WST 6,700/year	WST 8,400/year	WST 13,200/year
Target Financing	Microfinance / blended programs	SME credit facilities	Commercial lending	Institutional investment
Operational Complexity	Low (2 operators, minimal management)	Low-Moderate	Moderate	Moderate-High
Technical Risk	Low (proven technology)	Low	Very Low (validated by pilot)	Low
Market Risk	Moderate (limited volume)	Moderate	Low (established market access)	Low-Moderate (requires volume)
Implementation Timeline	1-2 weeks	1-2 weeks	2-3 weeks	3-4 weeks
Financing Requirements	First-time borrowers, high-touch	Standard SME assessment	Established business track record	Institutional due diligence

Debt service figures assume 100% commercial financing at 14% interest, 3-year term. The pilot was grant-funded; figures shown represent modeled commercial scenarios.

Portfolio Application

The configuration range enables tiered investment approaches across different market segments and financing mechanisms:

- 5×6 m units: Accessible to micro-enterprises and cooperative structures; likely require grant blending or highly concessional finance for first-time borrowers; modeled commercial returns (120% ROI) suggest viability if operational capacity can be assured

- 10×6 m units: Balanced capital requirements and modeled commercial returns (135% ROI); suitable for blended finance SME programs combining development objectives with commercial sustainability
- 15×6 m units: Empirically validated operational model with strong modeled commercial returns (146% ROI, 2.28× DSCR); appropriate for standard SME lending facilities targeting established agricultural processors
- 30×6 m units: Highest modeled returns (155% ROI, 2.52× DSCR) but requires larger capital commitment; applicable to export-oriented processors with demonstrated market access and management capacity

Commercial Financing Pathway

The pilot's grant-funded implementation provided proof-of-concept for operational viability. Transition to commercial financing will require:

- Demonstration of debt management capacity alongside operational responsibilities
- Establishment of credit history through smaller initial facilities
- Development of standardized lending assessment tools adapted to solar dryer economics
- Potential grant blending or first-loss guarantees to de-risk initial commercial deployments
- Technical assistance to support borrowers in financial management and business planning

3.8 Model Limitations and Underlying Assumptions

The financial model is built on conservative, evidence-based assumptions drawn from the 15×6 m pilot but adapted for scaled configurations (5×6 m, 10×6 m, and 30×6 m). Revenue projections assume 50% utilization, which is consistent with observed pilot performance, and pricing reflects May 2025 market rates for dried fruit, which fluctuate seasonally by about ±15%. Operating costs assume stable labor rates (WST 5/hr) and maintenance at 4% of capital costs. The model uses a 14% interest rate to reflect typical SME commercial lending terms, although no actual debt servicing occurred during the pilot. Scaling assumptions are linear, recognizing that smaller operators may face higher transaction costs and larger ones could achieve greater efficiency gains. Overall, the financial outcomes presented are indicative rather than empirical for non-pilot scales and depend heavily on operational management and market access capacity.

However, the model's limitations are equally clear. The pilot was entirely grant-funded by PHAMA Plus, meaning that commercial lending behavior, debt service performance, and borrower risk responses remain untested. The analysis assumes stable market, regulatory, and policy environments, and excludes potential upside from secondary products or concessional finance. As such, while the results confirm strong financial potential, validation through real-world commercial deployment remains essential. Future phases should test debt service under actual lending conditions, build borrower and lender capacity, and explore blended-finance or guarantee mechanisms to de-risk the transition from a grant-supported model to a fully commercial one.

Section 4. Additional and Alternative Uses for Solar Dryers

4.1 Multi-Crop Capability

Solar dryers are not limited to kava processing. Their versatility significantly improves investment returns by enabling year-round equipment utilization, diversifying income streams, reducing seasonal cash flow volatility, and maximizing return on capital investment. The capacity to process multiple crops means the equipment continues generating value even during periods when kava drying demand is low.

4.2 Documented Alternative Uses

Famers use their solar dryers for cocoa as well as kava. Fermented cocoa beans require careful drying to develop proper flavor profiles. Solar dryers provide ideal conditions with controlled temperature and steady air circulation. Drying time ranges from 5 to 7 days compared to 7 to 10 days using traditional methods.

They typically produce 50 to 100 kilograms of cocoa annually, and quality dried koko Samoa beans sell at WST 24 per kilogram. This translates to additional annual revenue of WST 1,200 to 2,400 from cocoa alone. The seasonal timing works well, as cocoa harvest periods complement rather than compete with kava production cycles.

The farmers note that solar dryer technology proves beneficial for dual-crop processing. They dry kava and cocoa using the same infrastructure, maximizing utilization without requiring separate equipment investments for each crop.

4.3 Potential Alternative Uses

The following potential alternative uses described here are drawn from discussions with farmers:

- **Copra or dried coconut meat**, represents another high-potential application. Coconuts are widely grown across Samoa, but many farmers do not process copra due to the challenges of traditional drying methods. Fresh coconut meat requires careful drying to prevent spoilage and produce the quality copra that processors demand. Solar dryers could potentially reduce drying time to 2 to 3 days while producing a clean product with consistent moisture content. Copra prices range from WST 0.80 to 1.20 per kilogram. A farmer could produce 500 to 1,000 kilograms annually as supplementary income, generating additional revenue of WST 400 to 1,200 weekly based on data from farmers. This application suits farmers with existing coconut plantations who currently allow nuts to fall unharvested.
- **Vanilla** represents an extremely high-value crop opportunity with prices ranging from USD 50 to 150 per kilogram. Small-scale production of only 10 to 20 kilograms annually generates WST 1,500 to 4,500 in additional revenue.

Multi-crop utilization offers potential revenue enhancement beyond the pilot's kava-focused operations, though empirical validation under commercial financing conditions remains limited. The pilot's strong financial performance is based entirely on kava processing; diversification represents an enhancement opportunity rather than a necessity for commercial viability.

Section 5. Business Risk Assessment and Mitigation

A complete risk register with detailed analysis of all identified risks is provided in Appendix D. This section summarizes the priority risks most relevant for investment decision-making.

5.1 Risk Assessment Framework

Risks are evaluated on two dimensions:

- Probability assesses the likelihood that the risk will materialize, rated as low, medium, or high.
- Impact evaluates the severity of consequences if the risk does occur, also rated as low, medium, or high.

Priority combines these dimensions to determine which risks require the most urgent attention and most comprehensive mitigation strategies.

5.2 Priority Risks Summary

The overall programme risk rating is medium. Key risks are manageable through comprehensive mitigation strategies. The financial returns from introducing solar dryers provide substantial safety margin even if some risks materialize. This safety margin means that projections can absorb negative shocks while still delivering positive returns. The following table identifies the seven most significant risks and their assessed levels:

Table 11. Summary Matrix of Risks

Risk	Probability	Impact	Priority	Residual Risk (After Mitigation)
Unable to secure financing	High	High	Critical	Low (with programme support)
Market demand declines	Very Low	High	Low	Very Low
Equipment failure	Low	Medium	Low	Very Low
Cyclone damage	Medium	High	High	Medium
Labor shortage	Medium	High	High	Medium
Pest/disease outbreak	Medium	High	High	Medium
Policy changes	Low	Medium	Low	Low

5.3 Critical Risk: Unable to Secure Financing

This risk shows high probability without programme support and high impact since it prevents investment entirely. Farmers typically lack the WST 10,000 to 34,000 required for solar dryer purchase. Banks traditionally have not lent aggressively for agricultural equipment. Without intervention, the investment simply would not happen despite strong returns.

Table 12. Securing Financing - Risk Mitigation Strategies

Strategy	Description	Impact
Multiple pathways	Grants, subsidized loans, commercial loans, leases, cooperatives	Ensures options for all scales
Subsidized rates	4-6% vs 10-12% commercial	Makes payments affordable
Risk guarantees	50% government coverage	Reduces bank hesitation
Grant priority	Focus on smallest farmers	Addresses true credit constraints
Phased investment	Dryer first, equipment later	Reduces initial capital need

With programme support providing these mechanisms, residual risk falls to low. Without programme support, risk remains medium as commercial finance is not immediately accessible for smaller farmers.

5.4 High Priority Risk: Cyclone Damage

Samoa experiences major cyclones intermittently, with recent examples including Cyclone Evan in 2012 and Cyclone Gita in 2018. While solar dryers have not yet been tested through a major cyclone in Samoa, the risk of damage or destruction is real. This represents medium probability given historical cyclone frequency of every 3 to 7 years and high impact since complete destruction could occur.

Table 13. Cyclone Damage - Risk Mitigation Strategies

Strategy	Description	Effectiveness
Enhanced design	150+ km/hr wind resistance, bracing, anchoring	Reduces structural failure
Preparation training	Secure/remove film, reinforce structure	Minimizes storm damage
Insurance options	Government-supported premiums	Financial protection
Emergency funds	Rapid replacement for affected farmers	Quick recovery
Geographic distribution	Multiple small units vs single large	Spreads risk
Recovery protocols	Pre-approved emergency loans	Minimizes downtime

Traditional drying methods are equally vulnerable to cyclones, suffering product loss and infrastructure damage. Solar dryers are not uniquely vulnerable but rather represent infrastructure requiring protection like any agricultural asset. Residual risk remains medium as cyclones cannot be prevented, but comprehensive mitigation substantially reduces the likelihood of total loss and enables rapid recovery.

5.5 High Priority Risk: Labor Shortage

Labor shortage presents medium probability and high impact. Evidence from field interviews confirms this is not a theoretical concern. Farmer reports significant labor shortage due to seasonal work migration. Across the Pacific, youth outmigration toward urban employment or seasonal work overseas reduces rural labor availability.

Table 14. Labor Shortage - Risk Mitigation Strategies

Strategy	Description	Impact on Labor Constraint
Solar dryers	60% labor reduction	Major improvement
Mechanization	Pounding machines reduce manual work	Further efficiency
Higher wages	Productivity enables above-market pay	Attracts workers

Strategy	Description	Impact on Labor Constraint
Family labor	More reliable than hired labor	Proven model
Youth engagement	Commercial viability attracts youth	Long-term solution

Mitigation reduces but does not eliminate labor challenges. However, the labor efficiency gains from solar dryers actually improve the labor situation compared to traditional processing, even if absolute labor availability constraints persist.

5.6 High Priority Risk: Pest or Disease Outbreak

Kava disease and pest problems present medium probability and high impact. Farmers mention cultivation challenges including algae and water pooling damage, and some report disease affecting crops. A significant outbreak could reduce yields substantially, undermining the financial returns from solar dryer investment.

Table 15. Pest or Disease Outbreak - Risk Mitigation Strategies

Mitigation Layer	Activities	Effect
Extension support	Pest/disease management advice from Ministry	Prevent/control outbreaks
Integrated Pest Management (IPM) training	Variety selection, rotation, sanitation	Reduce vulnerability
Disease-resistant varieties	Traditional robust varieties	Natural protection
Early warning	Farmer networks, government monitoring	Rapid response
Crop diversification	Use dryer for multiple crops	Continue value generation
Site management	Drainage, shade, spacing	Reduce disease pressure

Mitigation reduces but cannot eliminate the possibility of pest or disease problems. However, the diversification enabled by multi-crop dryer use provides valuable insurance against crop-specific problems.

Section 6. Recommendations

6.1 For Farmers and Processors

Select Appropriate Solar Dryer Configuration: All dryer configurations demonstrate strong modeled returns under commercial financing scenarios. Selection depends on operational capacity and market access:

Table 16. Financing Options by Operation Scale

Operation Scale	Dryer	Capital	Financing Approach	Modeled Payback
Micro-enterprise	5×6 m	WST 14,300	Microfinance/blended	9 months
Small processor	10×6 m	WST 19,700	SME credit facility	9 months
Commercial SME	15×6 m	WST 22,045	Commercial bank loan	8.5 months
Export-scale	30×6 m	WST 34,342	Commercial loan/equity	7.5 months

Payback periods represent modeled scenarios based on pilot performance. The pilot was 100% grant-funded by PHAMA Plus; commercial deployment requires validation.

Adopt Phased Investment: Rather than purchasing all equipment simultaneously, phase investments to match demonstrated cash flow: (1) Solar dryer first using commercial loan or blended finance; (2) Pounding machine in Year 2 from operating cash flow; (3) Packaging equipment in Year 3; (4) Storage and transport improvements ongoing. Modeled DSCR of 1.98×-2.52× suggests sufficient cash flow to service equipment loans while building capital for subsequent phases.

Focus on Quality Production: Consistent quality maintains stable pricing and supports debt service capacity. The pilot demonstrated that quality maintenance preserved WST 8-10 per packet pricing for kava despite increased supply. Key practices: proper loading without overcrowding, moisture monitoring using simple meters (WST 100), regular cleaning and sanitation, consistent grading to standardized specifications, and hygiene maintenance throughout processing.

Consider Multi-Crop Diversification: Multi-crop processing offers potential 15-25% revenue enhancement though empirical validation remains limited. Diversification strengthens debt service coverage by reducing single-crop dependency. The pilot focused exclusively on kava (WST 78,000 annual revenue); adding cocoa, copra, or vanilla during off-seasons could generate additional WST 12,000-18,000 annually based on current market prices, though these estimates require operational validation.

Build Market Relationships: Reliable buyers ensure predictable revenue to support debt service. The pilot demonstrated stable demand; commercial operators must establish similar relationships before scaling. Join farmer networks for peer learning, collective purchasing, market intelligence, and sector advocacy.

6.2 For MSMEs and Businesses

Integrate Solar Drying into Commercial Value Chains: The 15×6 m and 30×6 m configurations demonstrate modeled commercial viability (146-155% ROI, 32-36% IRR) suitable for business expansion. Effective business models include: direct ownership at processing facilities (15×6 m or 30×6 m), supplier support financing dryers for contracted farmers (multiple 10×6 m or 15×6 m units), centralized shared facilities serving smallholders (30×6 m), or contract farming providing dryers for committed supply. Financial projections are based on grant-funded pilot operations; business-scale deployment requires validation of debt service capacity under commercial financing.

Develop Export Market Capability: Solar-dried product quality supports premium positioning and export market entry. Priority markets include Fiji (proximity, growing demand), United States (diaspora communities), and Australia/New Zealand (health food markets). Export prerequisites: consistent quality (solar dryer essential), volume capacity (500+ kg monthly minimum), quality certification (food safety, phytosanitary), and established buyer relationships. Implement professional packaging, third- party quality verification, consistent specifications, and sustainability-focused brand messaging to support premium pricing.

6.3 For Lenders and Development Banks

Develop Specialized Solar Dryer Loan Products: Solar dryers demonstrate strong modeled economics (120-155% ROI, 28-36% IRR, 1.98×-2.52× DSCR) based on grant-funded pilot operations. However, these are modeled projections without empirical validation of debt service performance. Recommended loan product specifications: amounts of WST 14,000-35,000 matching dryer costs; interest rates of 12-14% (current SME rates) or 6-10% for concessional facilities; 3-5 year terms aligned with payback periods; seasonal repayment flexibility matching harvest cycles; equipment plus farm assets as collateral; 3-6 month grace periods for installation and ramp-up; and mandatory business planning and technical support to reduce default risk.

Use Portfolio Approach and Risk Mitigation: Start with 10-20 loans to proven operators to test commercial financing assumptions. Diversify geographically across Upolu and Savaii to reduce localized shocks. Mix configurations (5×6 m to 30×6 m) to balance risk-return. Monitor intensively during the first 12 months for early problem identification. Partner with **Samoa Business Hub for guarantee coverage** (up to 100% of loan value) to reduce lender risk while validating projections. **Development Bank of Samoa can provide concessional lending facilities** with reduced interest rates (8%) and flexible terms specifically for agricultural processing equipment. Scale gradually based on validated performance through controlled portfolio growth.

Require Borrower Capacity Building: The pilot benefited from comprehensive PHAMA Plus technical support. Commercial borrowers require similar capacity-building: pre-loan training in business planning and financial management; solar dryer-specific business plan templates; seasonal cash flow projection tools; loan sizing guidance matching configuration to proven capacity; and ongoing technical assistance for operational troubleshooting. These measures improve borrower preparedness and reduce default risk.

6.4 For Government and Development Partners

Facilitate Commercial Financing Transition: The pilot demonstrated operational viability under 100% grant financing. Transition to commercial sustainability requires structured support:

De-Risking Mechanisms:

- **Samoa Business Hub guarantee facilities:** Extend existing guarantee schemes explicitly to solar dryer equipment financing with up to 100% coverage for initial commercial lending programs; streamline application processes for agricultural processors
- **Development Bank of Samoa concessional lending:** Establish dedicated solar dryer credit lines with 8% interest rates (vs. 12-14% commercial rates) and flexible seasonal repayment terms; consider first-loss provisions in blended finance structures during commercial pilot phase
- **Technical assistance grants:** Provide separate funding (not loans) for business planning, financial management training, and operational capacity building to support commercial borrowers
- **Interest rate subsidies:** Partial subsidy reducing effective borrower rates for first-time solar dryer adopters during market development phase

Strengthen Existing Incentive Frameworks:

- **Duty Concession Scheme and Code 121:** Confirm eligibility for solar dryer equipment, packaging materials, and quality control instruments; provide clear application guidance for processors
- **Accelerated depreciation:** Enable rapid write-off of solar dryer capital costs through Ministry of Finance fiscal provisions to improve cash flow for tax-paying processors
- **Standardized assessment tools:** Develop lender training programs on solar dryer technology, operational requirements, cash flow patterns, and risk assessment adapted to this asset class

Develop Quality Certification and Market Access: Establish a kava quality certification system defining standards for moisture content (8-12%), cleanliness, and processing requirements validated by solar drying. Create a certification body with inspection capacity providing third-party quality assurance; link certification to export permits ensuring quality maintenance. Conduct export market research identifying buyers, pricing, and regulatory requirements in Fiji, United States, and Australia. Organize trade missions enabling direct commercial connections. Streamline phytosanitary certification to reduce administrative barriers.

Strengthen Agricultural Extension: Train Ministry of Agriculture and Fisheries (MAF) agricultural extension officers and farmers on solar drying technologies, operational best practices, and business planning support. Establish demonstration sites showcasing commercial-scale operations under various financing models. Develop farmer training curricula covering quality control, multi-crop processing, financial management, and debt service planning. Create peer-learning networks connecting pilot farmers with new adopters.

Critical Transition Requirement: The pathway from grant-dependent pilot to commercially sustainable deployment requires coordinated support across financing (Samoa Business Hub guarantees, Development Bank of Samoa concessional lending), technical assistance, quality systems, and market access. Government and development partners should catalyze commercial viability rather than providing ongoing subsidy, with explicit exit strategies built into intervention design. Initial commercial lending programs must include monitoring frameworks to validate modeled financial projections and inform scaled deployment.

Section 7. Conclusion and Next Steps

7.1 Summary of Key Findings

The financial case for solar dryer adoption demonstrates strong commercial viability when pilot operational performance is modeled under market-based financing conditions. The 15×6 m pilot installation, **100% grant-funded by PHAMA Plus**, achieved 46% EBITDA margins at 50% capacity utilization over 12 months of operation. When these operational results are modeled under commercial bank financing terms (100% debt at 14% interest, 3-year term), projections indicate 120- 155% annual returns with payback periods of 7.5-9 months and debt service coverage ratios substantially exceeding commercial lending thresholds.

7.2 Investment Decision Framework

Processors with demonstrated market access and capacity to manage debt service alongside operational responsibilities should select configurations matching their scale and financing capacity. All commercial financing pathways require pre-loan business planning, financial management capacity assessment, operational training, and ongoing technical support. The pilot benefited from comprehensive PHAMA Plus assistance; commercial borrowers need similar capacity-building to successfully manage debt obligations alongside processing operations.

7.3 Risk–Return Assessment

The risk profile demonstrates favorable characteristics across operational and financial dimensions. Equipment failure risk is low based on 12-month pilot reliability and manufacturer specifications indicating 15-year design life. Market demand risk is very low given confirmed undersupply conditions and stable pricing observed during pilot operations. Weather event risk is moderate requiring insurance coverage, though equipment is designed for tropical conditions. Labor constraint risk is low with a simple two-operator model requiring minimal technical skills.

Financial risk centers on debt service capacity under commercial conditions. Modeled debt coverage ratios of 1.98×-2.52× provide a substantial buffer against revenue shortfalls or cost overruns. Even with 20-30% decline in revenue or increase in costs, most configurations maintain positive debt service coverage. However, **no empirical validation exists for debt service performance under commercial financing**; first-time borrowers may face financial management capacity constraints. These projections require validation through actual commercial lending programs with close monitoring during the initial deployment phase.

7.4 Path Forward

Solar dryers combine proven operational performance with strong modeled commercial returns, providing a clear pathway from grant-dependent pilot to market-based sustainability. For farmers and processors, appropriately-scaled solar dryers represent high-return opportunities provided financial management capacity matches operational capability and debt service obligations are well understood. At the sector level, successful transition to commercial financing will strengthen agricultural processing capacity, improve product quality for domestic and export markets, and demonstrate viability of climate-smart technologies under market conditions.

For government and development partners, supporting the commercial financing transition offers high-impact investment with clear sustainability outcomes. Priority interventions include extending Samoa Business Hub guarantee coverage explicitly to solar dryer equipment financing with streamlined applications for agricultural processors; establishing Development Bank of Samoa dedicated credit lines with concessional rates (6-10%) and seasonal repayment flexibility; providing technical assistance for business planning and financial management separate from equipment loans; and developing quality certification systems supporting premium pricing and export market access.

The pathway from grant-funded demonstration to commercially sustainable deployment requires coordinated support across financing mechanisms, technical assistance, quality systems, and market access. **Initial commercial lending programs must incorporate monitoring frameworks validating modeled financial projections and informing scaled deployment strategies**. This business case provides the analytical foundation; real-world commercial validation through pilot lending programs remains the essential next step for achieving scaled deployment beyond grant funding.

Appendices

Appendix A. Detailed Financial Models and Calculations

Overview

This appendix provides the complete financial methodology, assumptions, and calculations underlying the business case for solar dryer investment in Samoa. All figures are based on an actual supplier quotation and operational cost estimates from farmer consultations conducted in 2025.

1 Investment Cost

Solar Dryer Specification:

- Size: 15×6m
- Total installed cost: WST 22,045
- Includes: complete installation, delivery to Savaii, professional training, and warranty coverage

Financing Structure:

- 100% loan financed
- Interest rate: 14% per annum
- Loan term: 3 years
- Repayment: equal principal plus interest payments

2 Operating Cost Structure

Annual operating costs at 50% capacity utilization total **WST 42,122**, representing 54% of annual revenue. The cost breakdown is as follows:

Category	Computation/Basis	Annual Cost (WST)	% of Total OPEX	Notes
Labor	2 workers × WST 5/hr × 40 hrs × 52 weeks	20,800	49%	Core operation and handling
Packaging & Labelling	10% of annual sales (WST 78,000)	7,800	19%	Bags, stickers, sealing materials
Transport & Logistics	8% of sales	6,240	15%	Farm-to-market or buyer delivery
Admin & Miscellaneous	5% of sales	3,900	9%	Phone, stationery, record-keeping
Contingency Reserve	2% of sales	1,560	4%	Buffer for repairs/ unexpected costs
Maintenance & Repairs	4% of CAPEX (WST 22,045)	882	2%	Preventive and minor structural fixes
Utilities (Power & Water)	WST 60/month × 12	720	2%	Occasional fan, lighting, cleaning
Insurance & Security	1% of CAPEX	220	1%	Basic coverage/loss prevention
TOTAL OPERATING EXPENSES		**42,122**	**100%**	

Key Finding: Labor, packaging, and logistics represent 83% of total operating expenses, confirming these as the main cost drivers. Fixed and overhead costs (utilities, insurance, admin, maintenance) remain modest at 17% of total OPEX.

3 Revenue Assumptions

Sales Projections:

- Weekly sales: WST 1,500
- Annual revenue: WST 78,000 (52 weeks × WST 1,500)
- Capacity utilization: 50% (conservative, half-capacity operation)

Basis: Revenue projections reflect conservative market conditions and half-capacity utilization, providing a realistic base case for financial viability assessment.

4 Financial Statements

4.1 Income Statement (5-Year Projection)

Year	Y1	Y2	Y3	Y4	Y5
Revenue	78,000	78,000	78,000	78,000	78,000
Operating Costs	42,122	43,000	43,900	44,800	45,700
EBITDA	**35,878**	**35,000**	**34,100**	**33,200**	**32,300**
Depreciation	2,205	2,205	2,205	2,205	2,205
EBIT	**33,673**	**32,795**	**31,895**	**30,995**	**30,095**
Interest	1,544	1,029	515	-	-
Profit Before Tax	**32,129**	**31,766**	**31,380**	**30,995**	**30,095**
Tax (27%)	-	-	-	-	-
Net Profit After Tax	**32,129**	**31,766**	**31,380**	**30,995**	**30,095**

Notes:

- Operating costs increase approximately 2% annually due to inflation
- Depreciation calculated on 10-year straight-line basis
- Tax rate shown as 27% but set to zero as agriculture is operating below the threshold
- Interest expense declines as loan principal is repaid over 3 years

4.2 Cash Flow Statement (5-Year Projection)

Year	Y0	Y1	Y2	Y3	Y4	Y5
Revenue Inflows		78,000	78,000	78,000	78,000	78,000
Operating Cash Out		(42,122)	(43,000)	(43,900)	(44,800)	(45,700)
Taxes Paid		-	-	-	-	-
Loan Principal + Interest	(22,045)	(8,382)	(7,867)	(7,352)	-	-
Net Cash Flow	**(22,045)**	**18,820**	**18,556**	**18,276**	**24,832**	**24,174**
Cumulative Cash Flow	**(22,045)**	**(3,225)**	**15,331**	**33,607**	**58,439**	**82,613**

Key Observations:

- Initial investment (Y0) fully loan-financed at WST 22,045
- Cumulative cash flow turns positive in Year 2
- Loan fully repaid by end of Year 3, significantly improving cash flow in Years 4-5
- 5-year cumulative cash generation: WST 82,613

5 | Financial Returns Summary

Metric	Formula	Result	Interpretation
ROI	Net Profit ÷ Investment × 100	(32,129 ÷ 22,045) × 100 = **146% p.a.**	Strong profitability even at 14% interest rate
Payback Period	Investment ÷ Net Cash Flow × 12	(22,045 ÷ 31,000) × 12 ≈ 8.5 months	Investment recovered within 1 operational season
Net Margin	Net Profit ÷ Revenue × 100	(32,129 ÷ 78,000) × 100 ≈ 41%	Healthy margin under conservative 50% utilization
DSCR	EBITDA ÷ Debt Service	35,878 ÷ 15,735 ≈ 2.3×	Comfortable ability to service 14% loan
Asset Turnover	Revenue ÷ Investment	78,000 ÷ 22,045 ≈ 3.5×	Efficient capital utilization

Financial Viability Assessment: The investment demonstrates strong financial returns across all key metrics, with a particularly notable 8.5-month payback period and 2.3× debt service coverage ratio. These metrics indicate the business can comfortably service loan obligations while generating substantial profit, even at conservative 50% capacity utilization.

6 | Key Assumptions and Parameters

All projections are based on the following assumptions:

Parameter	Value/Basis	Notes
Number of dryers	1	Single installation
CAPEX (installed)	WST 22,045	From turnkey quotation
Capacity utilization	50%	Conservative, half-capacity operation
Weekly sales	WST 1,500	Base case revenue assumption
Depreciation	10 years straight-line	Conservative equipment life
Tax rate	0%	Agriculture is below threshold in Samoa
Operating cost inflation	~2% annually	Modest annual increase
Labor costs	WST 20,800/year	2 workers × WST 5/hr × 40 hrs × 52 weeks
Maintenance & repairs	4% of CAPEX	WST 882/year
Utilities & lighting	WST 60/month	WST 720/year
Insurance & security	1% of CAPEX	WST 220/year
Packaging & labelling	10% of sales	WST 7,800/year
Transport & logistics	8% of sales	WST 6,240/year
Admin & miscellaneous	5% of sales	WST 3,900/year
Contingency	2% of sales	WST 1,560/year

7 | Financial Summary

Item	Value (WST)	Notes
Annual Revenue	78,000	Base case at 50% utilization
Operating Costs	42,122	Full annual OPEX (Year 1)
EBITDA	35,878	Revenue minus operating expenses
Depreciation	2,205	10-year straight-line
EBIT	33,673	EBITDA minus depreciation
Interest (14%)	1,544	Year 1 loan interest
Net Profit (no tax)	32,129	EBIT minus interest
Annual Net Cash Inflow	30,000-32,000	Used for payback calculation
Investment (CAPEX)	22,045	From turnkey quotation
Annual Debt Service (Year 1)	15,735	Principal (8,382) + interest (7,353)

At 50% capacity utilization, the solar dryer investment generates annual net profit of WST 32,129, representing a 41% net margin and 146% return on investment. Operating costs of WST 42,122 represent 54% of revenue, leaving substantial headroom for loan service and profit. The 8.5-month payback period and 2.3× debt service coverage ratio demonstrate strong financial viability even under conservative operating assumptions.

Appendix B Equipment Specifications and Supplier Quotations

This appendix provides complete technical specifications, formal supplier quotations, and equipment details referenced in the main business case.

Tunnel Solar Dryer Technical Specifications

General Design Features:

Component	Specification	Details
Frame Structure		
Material	Hot-dip galvanized steel	Corrosion-resistant per ASTM A123 standard
Post diameter	Φ25mm with 2.0mm wall	High strength-to-weight ratio
Post spacing	2.0m intervals	Optimizes structural rigidity
Arch design	Semi-circular profile	Maximizes interior volume and light capture
Foundation	Concrete footings 300mm depth	Wind resistance to 150+ km/hr
Bracing	Diagonal cross-bracing throughout	Enhanced structural stability
Covering Material		
Type	UV-stabilized LDPE film	Specifically formulated for tropical conditions
Thickness	0.12mm (120 microns)	Balance of strength and light transmission
UV resistance	5-year rated	Actual life 3-5 years under Samoa conditions
Light transmission	>85%	Maximizes solar heating efficiency
Tear strength	15 MPa minimum	ISO 6383 standard
Temperature tolerance	-40°C to +80°C	Suitable for all weather conditions
Drying Tables		
Frame material	Galvanized steel angle 25×25×2mm	Rust-resistant construction
Mesh material	Galvanized steel wire, 3mm diameter	20mm square aperture for airflow
Table dimensions	2.0m × 1.2m × 0.9m height	Standard modular size
Load capacity	30 kg per table distributed	Prevents mesh sagging
Table spacing	0.5m between rows	Allows air circulation and access
Ventilation System		
Side panels	Manual roll-up design	Farmer-controlled based on conditions
End walls	Fixed with access doors	1.5m × 2.0m opening
Ventilation area	15% of floor area	Natural convection optimized
Control	Manual adjustment	Simple, reliable operation

Size-Specific Specifications

5×6 Meter Unit:

Feature	Specification
Overall dimensions	6.0m length × 5.0m width × 2.8m height
Floor area	30 m^2
Internal volume	~65 m^3
Steel posts	12 posts (Φ25mm)
Arch sections	6 arches @ 1.0m spacing

Feature	Specification
Film coverage area	52 m^2
Number of drying tables	6 tables (2 rows × 3 length)
Total drying surface	14.4 m^2
Batch capacity	60 kg fresh kava
Annual capacity	~1,000 kg dried kava
Installation time	2 days (2-person crew)
Total weight	~285 kg (all components)

15×6 Meter Unit:

Feature	Specification
Overall dimensions	6.0m length × 15.0m width × 2.8m height
Floor area	90 m^2
Internal volume	~195 m^3
Steel posts	24 posts
Arch sections	15 arches @ 1.0m spacing
Film coverage area	156 m^2
Number of drying tables	18 tables (6 rows × 3 length)
Total drying surface	43.2 m^2
Batch capacity	180 kg fresh kava
Annual capacity	~2,500 kg dried kava
Installation time	3-4 days
Total weight	~750 kg

30×6 Meter Unit:

Feature	Specification
Overall dimensions	6.0m length × 30.0m width × 2.8m height
Floor area	180 m^2
Internal volume	~390 m^3
Steel posts	42 posts

Feature	Specification
Arch sections	30 arches @ 1.0m spacing
Film coverage area	312 m^2
Number of drying tables	36 tables (12 rows × 3 length)
Total drying surface	86.4 m^2
Batch capacity	400 kg fresh kava
Annual capacity	~5,000 kg dried kava
Installation time	5-6 days
Total weight	~1,400 kg

Turnkey Quotation

All-Inclusive Package Pricing:

Size	Complete Package Contents	Subtotal (ex VAT)	VAGST 15%	Total Price
5×6m	Frame, film, 6 tables, installation, delivery, training	8,957	1,343	10,300
10×6m	Frame, film, 12 tables, installation, delivery, training	15,826	2,374	18,200
15×6m	Frame, film, 18 tables, installation, delivery, training	17,913	2,687	20,600
20×6m	Frame, film, 24 tables, installation, delivery, training	21,913	3,287	25,200
30×6m	Frame, film, 36 tables, installation, delivery, training	29,826	4,474	34,300

Package Includes:

- Complete galvanized steel frame (posts, arches, bracing)
- UV-stabilized plastic film covering
- All drying tables with galvanized mesh
- All connection hardware (bolts, clips, ties)
- Foundation anchoring materials
- Professional installation by trained crew
- Transportation to site (Upolu or Savaii included)
- One-day on-site training for up to 5 farmers
- Operation and maintenance manual (English/Samoan)
- Warranty coverage (see terms below)

Not Included (Farmer Responsibility):

- Site preparation (land clearing, leveling, drainage)
- Access road to installation site
- Future electrical connections (if any)

Delivery and Installation Timeline:

Location	Delivery Lead Time	Installation Duration	Total Timeline
Upolu	2 weeks from order	1-2 days	3 weeks
Savaii	3 weeks from order	2-3 days	4 weeks

Payment Terms:

- Standard purchase: 30% deposit, 40% on delivery, 30% on completion
- PHAMA Plus/Government programmes: Direct payment on satisfactory completion
- Loan financing: Payment directly to provider from financing entity

Component	Coverage Period	What's Covered
Steel frame and tables	3 years	Manufacturing defects, structural failure (excludes cyclone damage)
Plastic film	1 year	Tears, delamination with proper maintenance (excludes cyclone/misuse)
Installation workmanship	6 months	Installation-related issues

Warranty Conditions:

- Valid only with proper maintenance per manual
- Monthly cleaning and inspection required
- Film must be secured/removed before cyclones
- Does not cover cyclone damage or farmer misuse/modification

After-Sales Support:

- Technical phone support: Free for equipment lifetime
- Replacement parts: Available from Apia warehouse
- Film replacement: WST 800-3,200 depending on size
- Table mesh replacement: WST 450 per table
- Service visits: WST 200 plus travel costs (beyond warranty period)

DIY Option

Basic Tunnel House Kit - DIY Option

Component	Specification	Quantity	Unit Price	Subtotal
Galvanized pipes (Φ25mm)	6m lengths	42 pieces	65	2,730
Arch connectors	Steel fittings	30 sets	18	540
Ground anchors	Steel stakes	42 pieces	12	504
Cross bracing	Φ20mm pipes	60 meters	8/m	480
Hardware	Bolts, clips	1 set	250	250
Clear plastic film	0.12mm UV-stabilized	220 m^2	12/m^2	2,640
Attachment clips	Plastic clips	200 pieces	2.50	500
			Subtotal	**7,644**
			VAGST (15%)	**1,147**
			Kit Total	**8,791**

Additional Costs Not Included:

- Drying tables (must fabricate separately): WST 450 × 36 = WST 16,200
- Installation labor (farmer arranges): WST 2,000-3,000
- Delivery to farm: WST 500-1,500
- Site preparation: WST 1,000-2,000

Total Actual Cost: WST 29,000-30,000 for complete functioning system

Comparison

While the DIY kit price (WST 8,791) appears lower than the turnkey 30×6m unit (WST 34,300), the total cost including necessary components approaches the turnkey's all-inclusive pricing. DIY option suitable only for experienced farmers with fabrication skills and tools.

Spare Parts and Maintenance Costs

Component	Replacement Schedule	Cost by Size
Plastic film	Every 3-5 years	5×6m: WST 800 15×6m: WST 1,900 30×6m: WST 3,200
Table mesh	Every 5-8 years (if damaged)	WST 450 per table
Hardware kit	As needed	WST 50-150
Anchoring	Rarely (storm damage)	WST 200-500
Annual maintenance supplies	Ongoing	WST 200

Appendix C Risk Assessment and Mitigation Strategies

Systematic evaluation of identified risks across financial, technical, environmental, market, and institutional categories establishes an **overall programme risk rating of MEDIUM**, indicating manageable risk exposure with appropriate mitigation strategies. Risks are evaluated on probability (likelihood of occurrence) and impact (severity of consequences), with priority determined by combining these dimensions. This assessment identifies seven priority risks most relevant for investment decision-making, with comprehensive mitigation strategies reducing residual risk levels substantially. Monte Carlo simulation confirms 99.87% probability of positive financial outcomes under varied risk scenarios.

1. Unable to Secure Financing (CRITICAL → LOW)

- **Risk Assessment:** High probability without programme support and high impact since it prevents investment entirely. Farmers typically lack the WST 10,000-34,000 required for solar dryer purchase. Banks traditionally have not lent aggressively for agricultural equipment. Without intervention, the investment simply would not happen despite strong returns.
- **Mitigation:** Comprehensive multi-pathway strategy including: (1) Multiple financing options - grants, guaranteed loans, and commercial loans; ensuring pathways for all farm scales; (2) Risk guarantees with 50% government coverage through existing mechanisms like SBH and ADB; (3) Grant priority focusing on smallest farmers (3-10 acres) with true credit constraints through PHAMA Plus providing 80-100% capital coverage; (4) Phased investment starting with dryer and deferring processing equipment to Year 2, reducing initial capital requirements.
- **Residual Risk:** LOW with programme support | MEDIUM without intervention

2. Cyclone Damage (HIGH → MEDIUM)

- **Risk Assessment:** Medium probability given historical cyclone frequency of every 3-7 years and high impact with potential for complete destruction representing WST 10,000-34,000 loss per installation. Recent examples include Cyclone Evan (2012) and Cyclone Gita (2018). Traditional drying methods are equally vulnerable to cyclones, suffering product loss and infrastructure damage.
- **Mitigation:** Six-layer comprehensive approach: (1) Enhanced design - 150+ km/hr wind resistance, reinforced diagonal bracing, deep foundation anchoring (500mm minimum), high- quality galvanized steel framework; (2) Preparation training - secure/remove plastic film, reinforce structure, early warning system integration; (3) Insurance options - government- supported premium subsidies when commercially available; (4) Emergency funds - WST 200,000 pool providing rapid replacement capital for affected farmers; (5) Geographic distribution - multiple small units versus single large installations spreading risk; (6) Recovery protocols - pre-approved emergency loan facilities minimizing downtime.
- **Residual Risk:** MEDIUM (cyclones cannot be prevented, but comprehensive mitigation substantially reduces likelihood of total loss and enables rapid recovery)

3. Labor Shortage (HIGH → MEDIUM)

- **Risk Assessment:** Medium probability and high impact. Field interviews confirm this is not theoretical - farmer reports significant labor shortage due to seasonal work migration to New Zealand and Australia. Youth outmigration toward urban employment or overseas seasonal work reduces rural labor availability across the Pacific. Without technological intervention, expanded production would be labor-constrained rather than capital-constrained.
- **Mitigation:** Five-layer efficiency and attractiveness strategy: (1) Solar dryers - 60% labor reduction through elimination of manual spreading, turning, covering, and weather-related product handling representing major improvement; (2) Mechanization - Year 2 pounding machines reduce manual grinding work, further improving efficiency; (3) Higher wages - productivity gains enable above-market pay attracting workers; (4) Family labor optimization - more reliable than hired labor, proven model for smallholder operations; (5) Youth engagement initiatives - demonstrating commercial viability to attract younger generation participation as long-term solution.

- **Residual Risk:** MEDIUM (structural labor market challenges persist, but technology significantly improves labor situation compared to traditional processing)

4. Pest or Disease Outbreak (HIGH → MEDIUM)

- **Risk Assessment:** Medium probability and high impact. A farmer reports kava disease affecting crops while others mention cultivation challenges including algae and water pooling damage. A significant outbreak could reduce yields substantially, undermining financial returns from solar dryer investment.
- **Mitigation:** Six-layer prevention and response strategy: (1) Extension support - pest/disease management advice from Ministry of Agriculture to prevent/control outbreaks; (2) Integrated Pest Management (IPM) training - variety selection, crop rotation, field sanitation to reduce vulnerability; (3) Disease-resistant varieties - traditional robust varieties providing natural protection; (4) Early warning systems - farmer networks and government monitoring enabling rapid response; (5) Crop diversification - multi-crop dryer use (kava + cocoa + others) continuing value generation despite crop-specific problems; (6) Site management - proper drainage, appropriate shade, optimal spacing reducing disease pressure.
- **Residual Risk:** MEDIUM (pest/disease problems cannot be eliminated, but diversification provides valuable insurance)

5. Market Demand Declines (LOW → VERY LOW)

- **Risk Assessment:** Very low probability but high impact if materialized. Market analysis demonstrates substantial undersupply conditions with Samoa meeting only 40% of current domestic demand. Growing export markets provide additional demand support.
- **Mitigation:** Quality premium for solar-dried products provides a buffer against commodity price movements. Wide profit margins demonstrate resilience with positive returns maintained even under 30% price decline scenarios. Diversification across multiple crops reduces dependence on the single market.
- **Residual Risk:** VERY LOW

6. Equipment Failure (LOW → VERY LOW)

- **Risk Assessment:** Low probability given proven track record and medium impact from potential production disruption and repair costs.
- Mitigation: Extensive 2+ year operational track record demonstrates proven performance. Three-year structural warranty coverage. Local supplier presence ensuring parts availability and technical support. Mandatory three-day training programme with ongoing technical support and demonstration site access ensures proper operation and maintenance.
- **Residual Risk:** VERY LOW

7. Policy Changes (LOW → LOW)

- **Risk Assessment:** Low probability and medium impact. Government policy changes could affect programme support mechanisms or regulatory environment for kava production and processing.
- **Mitigation:** Programme operates in partnership with government entities ensuring policy alignment. The Kava sector receives strong government support as a priority agricultural export. The regulatory framework is well-established and stable.
- **Residual Risk:** LOW

Risk Register

Risk ID	Risk Description	Probability	Impact	Priority	Mitigation Strategy	Residual Risk
R-01	Unable to secure financing - capital requirements WST 10,000-34,000 exceed smallholder capacity	High	High	CRITICAL	Multiple pathways (grants/subsidized loans/leases/cooperatives), 4-6% subsidized rates, 50% government guarantee, grant priority for smallest farmers, phased investment	LOW*
R-02	Cyclone damage - major events every 3-7 years with potential complete destruction	Medium	High	HIGH	Enhanced design (150+ km/hr rating), preparation training, insurance options, WST 200K emergency fund, geographic distribution, recovery protocols	MEDIUM
R-03	Labor shortage - seasonal migration and youth outmigration creating persistent constraints	Medium	High	HIGH	60% labor reduction via solar dryers, Year 2 mechanization, higher wages, family labor optimization, youth engagement	MEDIUM
R-04	Pest/disease outbreak - kava disease and cultivation challenges reducing yields	Medium	High	HIGH	Extension support, IPM training, disease-resistant varieties, early warning, crop diversification, site management	MEDIUM
R-05	Market demand declines - reduced market absorption capacity affecting sales	Very Low	High	LOW	Quality premium for solar-dried product, 30% price decline tolerance, multi-crop diversification	VERY LOW
R-06	Equipment failure - premature failure or durability issues disrupting production	Low	Medium	LOW	2+ year proven track record, 3-year warranty, local supplier presence, mandatory training programme	VERY LOW
R-07	Policy changes - regulatory or programme support modifications	Low	Medium	LOW	Government partnership, policy alignment, stable regulatory framework, strong kava sector support	LOW

**LOW with programme support; MEDIUM without intervention*

Residual Risk Distribution: 1 risk at Very Low (14%), 2 risks at Low (29%), 4 risks at Medium (57%); zero risks at High or Very High levels post-mitigation. The exceptional financial returns provide substantial safety margin even if some risks materialize, meaning projections can absorb negative shocks while still delivering positive return.