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Farm Youth Entrepreneurship in Circular Bio-Based Ventures

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Abstract

Rural youth entrepreneurship is increasingly important for employment creation, agricultural renewal, local value addition, and the transition toward more resource-efficient food systems. Circular bio-based ventures provide a particularly relevant entrepreneurial pathway because agricultural production generates crop residues, livestock by-products, food-processing side streams, organic nutrients, and other biological resources that can be converted into products or services rather than treated solely as waste. This conceptual–methodological study develops a Farm Youth Circular Bio-Venture Framework linking locally available biological resources with entrepreneurial capability, appropriate technology, market demand, partnerships, and circular value retention. The analysis distinguishes relatively accessible ventures, including compost and biofertilizer production, residue-based growing media, mushroom substrates, feed upgrading, and decentralized bioenergy services, from more technologically demanding ventures involving advanced biomaterials and bio-based packaging. Existing research on agro-waste valorization shows that viable circular businesses depend not only on conversion technology but also on logistics, market pull, regulation, partnerships, resource consistency, and organizational capability.

Research on rural youth similarly identifies finance, skills, market access, connectivity, and agency as important constraints on successful entrepreneurship. A scenario-based analytical model is used to compare the simulated viability of five circular bio-based venture categories. Because no primary youth-enterprise dataset was supplied, all numerical results are explicitly illustrative and should not be interpreted as empirical observations. The paper argues that circular bio-based entrepreneurship becomes more feasible for farm youth when ventures begin with locally abundant residues, comparatively simple processing technologies, identifiable customers, shared equipment, and business-development support. The resulting framework provides a basis for future field surveys, business incubation programs, enterprise trials, and longitudinal studies of rural circular entrepreneurship.

Keywords: farm youth entrepreneurship, circular bioeconomy, agripreneurship, agricultural residues, bio-based ventures, rural enterprise, waste valorization, circular business models

1. Introduction

Agriculture remains an important source of livelihoods in many rural economies, yet participation in primary production alone does not always provide sufficient income or attractive career pathways for younger generations. Rural youth frequently encounter limited access to productive assets, finance,

formal employment, entrepreneurial training, markets, and business networks. IFAD's rural-youth analysis emphasizes that young people constitute a major component of the rural population in developing economies and that their capacity to participate productively in changing agrifood systems has significant implications for employment, food security, and rural transformation. The same evidence shows that youth-owned enterprises often face constraints related to experience, business skills, finance, and the transition from dependence to economically viable independent livelihoods.

At the same time, agricultural systems generate substantial volumes of biological side streams that frequently retain economic and functional value. Crop straw, husks, shells, pruning residues, manure, food-processing residues, dairy by-products, spent grain, fruit and vegetable residues, and other organic materials can potentially enter additional production cycles. Gregg and colleagues show that bio-residual valorization depends on resource procurement, handling, transformation, markets, regulation, technology, business strategy, and actor networks. Their review demonstrates that biological residues should not be understood simply as waste awaiting disposal; their usefulness depends on whether a functioning value chain can connect available material with viable end uses.

The circular bioeconomy provides a conceptual foundation for linking these two challenges. Circular approaches seek to keep biological resources in productive use, create higher-value applications where feasible, recover nutrients, reduce avoidable waste, and use cascading pathways before lower-value final uses. Donner, Gohier, and de Vries identify multiple business configurations for agricultural waste valorization, including upcycling enterprises, biogas systems, cooperatives, agriparks, and supporting organizations. Their analysis emphasizes that circular agricultural ventures depend heavily on partnerships and connections across previously separate value chains. Circular bio-based entrepreneurship can therefore create roles for young people not only as farmers but also as processors, service providers, aggregators, technology operators, marketers, and coordinators of local resource loops.

However, the existence of agricultural residues does not automatically create profitable youth businesses. Biological materials are frequently seasonal, geographically dispersed, heterogeneous, bulky, perishable, or costly to transport. Potential products may require quality control, licensing, testing, specialist equipment, reliable customers, or technical knowledge. Studies of circular agricultural businesses identify technical and logistical conditions, finance, marketing, organizational structures, regulation, local stakeholder acceptance, and technological capability as major success and risk factors. For young entrepreneurs with limited capital and collateral, a technologically sophisticated venture may consequently be less feasible than a smaller enterprise based on simple transformation and a clearly identified local market.

The present study develops a framework for evaluating Farm Youth Entrepreneurship in Circular Bio-Based Ventures according to this practical reality. It proposes that youth entrepreneurship should begin with a local resource–market fit rather than with technology selection alone. Five venture groups are considered: compost and biofertilizers, residue-based mushroom or growing media, feed and by-product upgrading, decentralized bioenergy services, and bio-based materials or packaging. Because no primary enterprise survey, financial dataset, or pilot project has been supplied, the paper is explicitly conceptual and simulation based. Its contribution is a structured model connecting youth entrepreneurial

capability with circular resource availability, business-model design, partnerships, and venture complexity.

2. Objectives of the Study

2.1 To Develop a Farm Youth Circular Bio-Venture Opportunity Framework

The first objective is to develop a practical analytical framework through which agricultural residues and biological side streams can be screened for youth-enterprise potential. The framework considers local material availability, collection distance, processing difficulty, required capital, technical skills, product shelf life, regulatory requirements, customer demand, and the possibility of using shared infrastructure.

The purpose is to prevent a common entrepreneurship problem in which a technology is promoted before the underlying feedstock and market conditions have been validated. A viable circular venture should begin with a recurring biological resource and a credible customer problem. Conversion technology then provides the bridge between the two.

2.2 To Identify the Entrepreneurial Capabilities and Ecosystem Support Required for Venture Survival

The second objective is to determine the capabilities young rural entrepreneurs require beyond agricultural production knowledge. These include business planning, costing, customer discovery, quality control, digital marketing, logistics management, partnership development, financial literacy, and compliance awareness.

The study also examines the supporting ecosystem surrounding youth ventures. Training alone may have limited effect when young entrepreneurs lack access to equipment, working capital, buyers, mentors, certification services, or aggregation networks. Rural youth entrepreneurship is therefore approached as an ecosystem challenge rather than solely an individual-skills problem.

2.3 To Compare the Relative Accessibility of Different Circular Bio-Based Venture Types

The third objective is to compare several venture pathways according to simulated entrepreneurial viability. The analysis does not attempt to determine which technology produces the highest scientific conversion efficiency. Instead, it evaluates the likely entry feasibility for young rural entrepreneurs based on capital intensity, technical complexity, feedstock access, market familiarity, and partnership requirements.

This distinction is important because a lower-technology business can create stronger local employment when it reaches commercial viability, whereas an advanced technology with weak market demand or high capital requirements may remain inaccessible despite technical potential.

3. Review of Literature

3.1 Rural Youth, Agripreneurship, and Enterprise Constraints

Rural youth are frequently described as potential agents of agrifood transformation, but their participation is shaped by structural constraints. IFAD identifies productivity, connectivity, and agency as important foundations for rural youth development and highlights the need for employment and entrepreneurship opportunities extending across expanding agrifood systems. FAO similarly identifies

limited access to skills, land, finance, decision-making structures, and market opportunities as recurring obstacles to youth participation in agriculture.

Evidence from agribusiness interventions suggests that enterprise programs perform more effectively when several forms of support are combined. A review of African rural youth engagement in agribusiness found that interventions integrating capacity development, start-up finance, and continuing technical and financial mentorship produced more favorable outcomes than isolated training initiatives. FAO program experience likewise indicates that youth entrepreneurship can benefit from technical training, mentoring, business-plan development, financial support, and linkages with agricultural value chains.

These findings have direct implications for circular bio-based ventures. Young entrepreneurs entering residue valorization need competencies from both agriculture and enterprise development. They may have to negotiate residue supply agreements, calculate transportation costs, maintain quality specifications, manage seasonal inventory, market unfamiliar products, and demonstrate environmental or agronomic value to customers. Entrepreneurial capability therefore includes the ability to coordinate a new local value chain rather than simply operate a conversion technology.

3.2 Circular Bioeconomy and Agricultural Residue Valorization

Circular bioeconomy literature emphasizes the productive use of renewable biological resources while maintaining resource efficiency and value through multiple applications. Research on European bioeconomy clusters identifies residues and wastes as increasingly important feedstocks and highlights cascading, integrated processing, and higher-value material applications as key circular strategies. Biomass valorization research similarly demonstrates that agricultural residues can support energy, materials, chemicals, soil products, and other value-added uses when conversion technologies are matched with resource characteristics and market demand.

Donner, Gohier, and de Vries provide particularly relevant evidence for agricultural entrepreneurship. Their analysis of circular agro-waste businesses identifies six broad business-model configurations and shows that circular ventures rely on new supplier–customer relationships, reverse logistics, partnerships, and cross-sector organization. The study also emphasizes the principle of using biomass for higher-value products where feasible before lower-value energy recovery.

Gregg and colleagues similarly demonstrate that valorization pathways differ substantially among sectors. Some residual streams develop strong markets because processing capabilities and customer demand already exist, whereas other streams remain underused because of weak market pull, regulation, poor logistics, or high investment requirements. This evidence warns against treating agricultural waste as inherently valuable. Economic value emerges only when a reliable chain connects collection, processing, product quality, customer demand, and end use.

3.3 Circular Business Models and the Youth Entrepreneurship Research Gap

Circular business-model research increasingly recognizes that technical innovation alone is insufficient. Studies of agricultural residue businesses identify a combination of technological, organizational, economic, regulatory, spatial, and market factors that influence venture survival. In particular, flexible logistics, partnerships with research organizations, joint investment, local stakeholder acceptance, price

competitiveness, and regulatory conditions can determine whether a valorization pathway becomes commercially viable.

Research on small and medium-sized circular bioeconomy firms reaches a similar conclusion. D'Amato, Veijonaho, and Toppinen identify renewable resources, technological innovation, and key partnerships as strategic assets within circular bioeconomy business models. The implication for youth entrepreneurship is significant: business opportunities exist not only in manufacturing final products but also in aggregation, processing services, resource brokerage, equipment operation, biological treatment, and market coordination.

A research gap remains at the intersection between these two bodies of literature. Rural-youth studies frequently focus on agriculture, agribusiness employment, finance, and skills, whereas circular bioeconomy studies commonly emphasize technologies, established firms, industrial value chains, and waste valorization. Less attention is given to how circular biological-resource loops can be deliberately designed as entry-level entrepreneurial pathways for farm youth. The present study addresses this gap through a youth-centered venture-screening and ecosystem framework.

4. Research Methodology

4.1 Conceptual–Methodological Research Design

The study employs a conceptual–methodological design based on structured synthesis of literature concerning rural youth entrepreneurship, agribusiness development, circular business models, agricultural residue valorization, bioeconomy, and rural value chains. The study does not claim to report original interviews, enterprise accounts, field experiments, or financial records from youth-owned businesses.

The unit of analysis is the circular bio-based youth venture, defined as a rural enterprise that creates economic value by retaining, transforming, recovering, circulating, or upgrading renewable biological resources that would otherwise be underused or discarded.

4.2 Venture Screening and Classification Procedure

The conceptual screening model evaluates potential ventures using six dimensions: feedstock security, technical accessibility, capital requirement, market accessibility, partnership dependence, and circular-value contribution. These dimensions were selected because the literature consistently indicates that residue availability and technological feasibility must be considered alongside logistics, markets, business capability, regulation, and actor networks.

Table 1: Farm Youth Circular Bio-Venture Screening Framework

Assessment Domain	Core Question	Favorable Entry Condition	Primary Entrepreneurial Risk
Feedstock security	Is the biological resource consistently available?	Local, predictable and low-cost residue stream	Seasonal shortage or competition for biomass

Assessment Domain	Core Question	Favorable Entry Condition	Primary Entrepreneurial Risk
Technical accessibility	Can youth operate the process safely and reliably?	Simple or modular technology with available training	Product failure or unsafe processing
Capital intensity	Can the enterprise start at realistic scale?	Low initial equipment and working-capital requirement	Debt pressure and underutilized equipment
Market accessibility	Is there a recognizable paying customer?	Existing local demand or clear substitute product	Technology push without market pull
Partnership requirement	Which capabilities must be obtained externally?	Accessible extension, laboratory, cooperative or buyer support	Excessive dependence on one partner
Circular contribution	Does the venture retain biological value effectively?	Reuse, nutrient recovery, upcycling or cascading	Low-value disposal presented as circularity

The framework does not assume that ventures scoring highly on every dimension are available in every locality. The relative attractiveness of a venture depends on actual farm systems, residue types, customer demand, infrastructure, regulation, culture, and climate.

4.3 Scenario Construction and Venture Viability Index

Five venture categories were selected for scenario analysis. These categories represent progressively different combinations of technological and market complexity: compost and biofertilizer production; mushroom substrate or growing media from residues; feed and by-product upgrading; decentralized bioenergy services; and bio-based materials or packaging.

A conceptual Youth Venture Viability Index (YVVI) is expressed as:

$$YVVI=\frac{F+T+C+M+P+R}{6}$$

where:

(F) = feedstock security, (T) = technical accessibility, (C) = capital accessibility, (M) = market accessibility, (P) = partnership support, and (R) = resource-circularity potential.

The index is not a validated entrepreneurship scale. It is used only to make the scenario assumptions transparent. Actual venture appraisal would require enterprise-specific cost data, market research, technical trials, regulatory evaluation, and sensitivity analysis.

5. Analysis

5.1 Opportunity Structure for Farm Youth

The conceptual analysis suggests that circular bio-based entrepreneurship should begin close to existing agricultural activities. Farm youth often possess advantages that external entrepreneurs may not have: knowledge of crop seasons, access to farmer networks, familiarity with agricultural problems, awareness of local residue streams, and relationships with potential users of soil amendments, feed products, or agricultural services.

These advantages are most valuable when paired with technologies that can operate at relatively small scale. Composting, vermicomposting, biological soil amendments, residue-based growing media, mushroom substrates, feed preparation, and selected bioenergy services can potentially be introduced incrementally. Advanced biomaterials or biochemical ventures can offer higher unit value but generally require stronger testing, process control, quality assurance, financing, and specialized market relationships.

The analysis therefore favors an entrepreneurial capability ladder. Youth entrepreneurs can begin with lower-complexity ventures, establish customers and operational capability, and subsequently move toward more sophisticated valorization as finance, partnerships, and technical knowledge develop.

5.2 Simulated Viability of Circular Bio-Based Youth Ventures

The scenario model assigns hypothetical viability scores to five venture categories. These values are illustrative and do not represent observed profitability, survival rates, or investment returns.

Table 2: Simulated Youth Venture Viability Across Circular Bio-Based Activities

Circular Bio-Based Venture	Simulated Viability Index (%)	Principal Entry Advantage	Principal Constraint
Compost and biofertilizer	84	Low-to-moderate technology and familiar agricultural market	Quality consistency and customer confidence
Mushroom/growing media from residues	78	Converts local residues into higher-value production inputs	Biological process management
Feed and by-product upgrading	72	Existing livestock-related demand in suitable areas	Safety, formulation and regulatory requirements
Small-scale bioenergy services	66	Energy and residue-management benefits	Equipment cost and utilization requirements
Bio-based materials and packaging	59	Potential access to higher-value emerging markets	R&D, certification, scale and market-development needs

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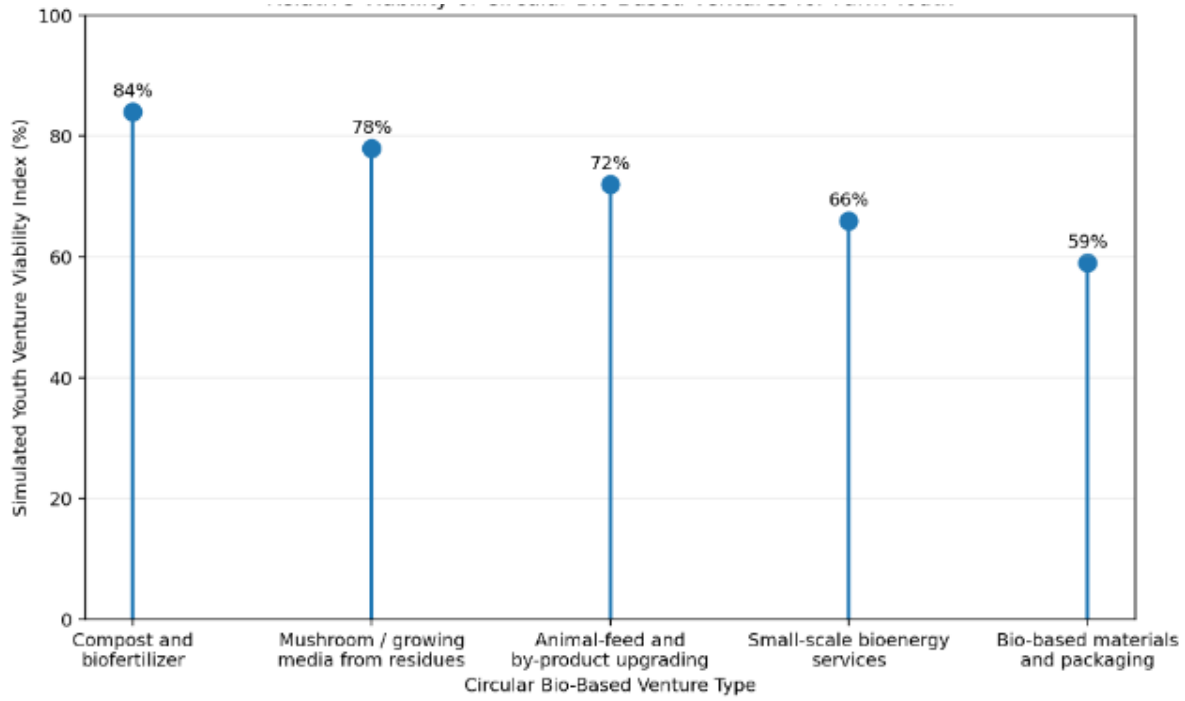
Note: All numerical values are simulated for conceptual analysis and do not represent actual youth businesses or financial returns.

The results indicate that the highest simulated viability is associated with ventures that combine locally available feedstocks, comparatively understandable technology, moderate start-up requirements, and customers already familiar with the general product category. More advanced ventures receive lower entry scores not because they lack environmental or economic potential but because they generally require a stronger entrepreneurial ecosystem.

Graph 1: Relative Viability of Circular Bio-Based Ventures for Farm Youth



Interpretation: The lollipop graph shows a declining simulated entry-viability pattern as technological complexity and market-development requirements increase. Compost and biofertilizer ventures reach an illustrative score of 84%, followed by residue-based growing media at 78% and feed upgrading at 72%. Bioenergy services and bio-based materials remain potentially attractive but require greater financial, technical, regulatory, and partnership capability.

5.3 Building a Youth Circular Enterprise Ecosystem

The analysis suggests that training young entrepreneurs without creating supporting market and infrastructure systems is unlikely to generate durable enterprises. A circular venture may require laboratory testing, processing equipment, storage, transport, packaging, business registration, certification, financial services, or buyer contracts that a single youth enterprise cannot efficiently provide alone.

Shared infrastructure therefore becomes particularly important. Producer organizations, youth business hubs, technical institutions, cooperatives, incubation centers, municipalities, and private companies can provide equipment pools, processing space, quality-testing services, mentorship,

aggregation, and market linkages. IFAD's broader work on rural youth emphasizes the importance of connecting young entrepreneurs with finance, skills, markets, networks, and institutional support.

Digital tools can further reduce transaction costs. Youth-led ventures may use mobile platforms to identify residue suppliers, coordinate collection, advertise products, maintain customer records, aggregate orders, or share equipment schedules. Digitalization cannot resolve weak product economics, but it can improve visibility and coordination within fragmented rural resource networks.

6. Discussion

6.1 Circular Entrepreneurship Can Reframe Agricultural Residues as Local Productive Assets

The first implication is that circular bio-based entrepreneurship can change the economic meaning of agricultural residues. A residue that imposes disposal costs or is burned, dumped, or left underused may become an input for another farm or rural enterprise when collection, processing, and customer demand are coordinated.

This transformation is consistent with circular business-model research demonstrating that agro-waste valorization requires new relationships among suppliers, customers, processing technologies, and partner organizations. Donner, Gohier, and de Vries show that successful models frequently cross conventional sector boundaries and depend on networks rather than isolated firms.

Farm youth may be particularly well positioned to occupy this coordinating space because they can combine agricultural familiarity with new business and digital capabilities. However, policy programs should avoid assuming that every residue automatically provides an entrepreneurial opportunity. Feedstock quality, transport distance, competing uses, conversion cost, and customer willingness to pay remain decisive.

6.2 Youth Ventures Should Follow Cascading Value Rather Than Waste-Disposal Logic

A second implication concerns how biological residues are prioritized. Circular bioeconomy thinking generally favors retaining the highest feasible value before moving toward lower-value uses. For example, a clean agricultural side stream suitable for feed, food ingredients, growing media, or biomaterials may provide greater functional value than immediate combustion, whereas material unsuitable for higher-value applications may reasonably enter energy recovery or nutrient cycling.

Donner and colleagues' business-model analysis highlights the importance of cascading and higher-value applications in agricultural residue systems. Research on biomass refining similarly emphasizes that biological feedstock characteristics and the intended product pathway determine the competitiveness and sustainability of conversion strategies.

Youth entrepreneurship programs should therefore teach resource assessment as well as enterprise development. Entrepreneurs need to ask what the material can safely become, which uses preserve the greatest value, which customers exist, and what processing intensity is economically justified. Circularity should not become a label attached to any activity that happens to use waste.

6.3 Finance, Mentorship, and Market Access Are More Important Than Technology Demonstrations Alone

Many rural innovation initiatives successfully demonstrate a technology but fail to establish a durable business model. A processing machine may function technically while remaining idle because the enterprise cannot secure feedstock, maintenance, working capital, or customers. Circular youth enterprises face this risk particularly strongly because new bio-based products may require customer education and repeated quality assurance.

Rural-youth evidence supports combined intervention models. Programs integrating training with financial support and ongoing mentoring show stronger potential than one-time technical instruction. IFAD likewise emphasizes that youth entrepreneurship is strengthened when young people can access productive assets, connectivity, markets, finance, and institutional networks rather than being treated as isolated start-up founders.

A practical incubation model should therefore progress through resource mapping, customer discovery, small technical trials, costing, pilot sales, quality verification, and gradual scale-up. Large capital investment should follow demonstrated demand rather than precede it. This sequence can reduce the probability that young entrepreneurs become financially committed to technologies before commercial viability has been established.

7. Conclusion

Farm youth entrepreneurship and the circular bioeconomy can be productively connected through enterprises that convert agricultural side streams into useful products and services. The strongest opportunities are not determined by technological novelty alone. They emerge where locally available biological resources can be transformed safely and affordably into products for which identifiable customers are willing to pay.

The framework developed in this study emphasizes six venture conditions: secure feedstock, accessible technology, realistic capital requirements, market demand, supportive partnerships, and genuine resource circularity. The scenario analysis suggests that compost, biofertilizers, residue-based growing media, and selected feed-upgrading activities may provide comparatively accessible entry points, while decentralized bioenergy and advanced bio-based materials generally require progressively stronger technology, finance, regulation, and market support. These scores are illustrative and require empirical validation.

The broader implication is that youth circular entrepreneurship should be developed as an ecosystem rather than a collection of isolated start-ups. Research institutions can support testing and product development; financial organizations can provide appropriate capital; farmer organizations can aggregate feedstock; incubators can provide business mentoring; regulators can establish proportionate standards; and buyers can create predictable market pull. When these relationships are coordinated, circular bio-based ventures can simultaneously create rural employment, retain greater value from agricultural resources, reduce avoidable waste, and diversify the economic roles available to younger generations within agrifood systems.

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