AN INNOVATIVE AGRO- SUSTAINOPRENEURS BUSINESS MODEL OF RURAL AND PERI- URBAN EMPOWERMENT: UTILISATION, OPTIMISATION, AND COMMERCIALISATION OF BANANA FIBRE IN TAMIL NADU

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Abstract
The purpose of this research is to investigate a method that is both sustainable and dynamic, namely social entrepreneurship, for addressing issues related to rural livelihoods. This research is being carried out in Tamil Nadu, a state in India where banana production is rather popular. The findings of this study indicate that banana fibre is a mostly underutilised agricultural waste that has the potential to lead to rural development. The purpose of this article is to explore the degree to which strategic efforts in the utilisation, optimisation, and monetization of banana fibre correspond with the Sustainable Development Goals (SDGs) in order to offer a meaningful and demonstrable social effect in rural areas.

This research studies the process of converting discarded banana stems into fibre that may be put to beneficial use. There is a strong emphasis placed on utilisation as the first step towards enhancing environmental sustainability and resource efficiency. The optimisation variable refers to the ways in which technical and operational advancements might improve the quality of the fibre, reduce the costs of processing, and raise worker productivity, hence making the banana fibre value chain more realistic and inclusive. To guarantee that every step of the research model, from resource recovery to income generation, holistically promotes rural development, gender equality, environmental preservation, and dignified employment, the Sustainable Development Goals have been included into the research model as a framework. In the research, social effect and rural empowerment are ranked as dependent outcomes. These results are assessed by increased income levels, job possibilities, community engagement, and improvements in the quality of life in rural Tamil Nadu. This article contributes to the ongoing discussion on sustainable social enterprises by presenting an approach that is both scalable and repeatable, to reduce poverty in rural areas and incorporate concepts of circular economies and sustainable lives into rural development.

Keywords: Sustainable Development Goals, Utilisation, Regression.

INTRODUCTION

The bottom of the pyramid (BOP) was seen as the base of the economy that had a lot of promise for consumers and entrepreneurs (Prahalad and Hart 2002). Prahalad mainly talks about how to reduce poverty by making money. He says that include the Bottom of the Pyramid (BOP) in the economy is very important for encouraging entrepreneurship and innovation at the grassroots level. Because of this, business models at the Bottom of the Pyramid (BOP) are considered as ways for entrepreneurs to make money and create opportunities by meeting the needs of low-income people, who have traditionally been perceived as socially and economically disadvantaged and underserved.

According to Prahalad, the bottom of the pyramid is the group of people who make less than $2 a day. The term refers to roughly 4 billion people throughout the world, which is majority of the population. However, traditional markets typically ignore them. One way to look at it is to include the BOP market in the larger social and economic picture. The point of view explains how private business activities lead to new investments, encourage long-term innovation at the base of the pyramid, and support local empowerment, job creation, and a range of products and services that meet the needs of the poor (Aworh, 2021).

Agro-Sustainopreneurs Meaning and Importance
The term "Agro-Sustainopreneurs" combines three important ideas: agriculture, sustainability, and entrepreneurship. Together, they provide a new way for rural and peri-urban economies to thrive. An Agro-

Sustainopreneur is an individual or collective that identifies innovative opportunities within the agricultural sector to create environmentally sustainable and socially responsible businesses. These business owners go beyond the usual goal of making money; their goals include protecting the environment, empowering communities, and making the best use of natural resources. They work within the framework of the Sustainable Development Goals (SDGs) to make sure that farming methods make money while also protecting the environment, making the best use of resources, and promoting fair social and economic progress. Agro-Sustainopreneurs are the best example of sustainability-oriented entrepreneurship. They improve rural life via innovation, using resources in cycles, and giving people more power in their communities.

This article connects Agro-Sustainopreneurship to the utilisation, optimisation, and monetization of banana fibre in Tamil Nadu. Tamil Nadu is one of India's largest banana-growing states, therefore after the harvest, it leaves behind a lot of agricultural waste in the shape of banana pseudostems. People usually toss these stems away or let them rot, which releases greenhouse gases and makes the environment worse. The Agro-Sustainopreneurial plan sees this waste as a useful raw material that can be turned into eco-friendly commodities that are in great demand, such textiles, paper, ropes, matting, and composite materials. From the point of view of sustainopreneurship, turning trash into riches not only helps the environment, but it also creates long-term business opportunities in rural and peri-urban regions.

By calling rural individuals and self-help groups "Agro-Sustainopreneurs," the effort creates an entrepreneurial environment that links agriculture, innovation, and sustainability. Farmers and local craftspeople may take part in value-added operations that go beyond traditional farming, such as extracting fibre, processing it, and making products. People may diversify their income, improve their lives, and become more resilient to changes in the market by moving from plain farming to being part of the value chain. Agro-Sustainopreneurship also encourages localised production techniques, which makes communities less dependent on outside intermediaries and gives them more control over their own businesses. It changes people who live in rural areas from being passive producers of raw agricultural goods to active participants in sustainable economic systems. This helps rural areas become more self-sufficient and powerful.

The connection between the idea of Agro-Sustainopreneurs and the present study is based on its emphasis on sustainability that is driven by new ideas. The study highlights three fundamental processes—utilisation, optimisation, and commercialisation—that together form the operational framework of Agro-Sustainopreneurship. Utilisation is the first step in the process of properly reclaiming and reusing agricultural leftovers, such banana stems. Optimisation is the process of improving processing technology and operating efficiency to improve fibre quality, lower costs, and make sure that workers are paid fairly. The commercialisation phase focuses on building market contacts, developing branding strategies, and creating business models that will make banana fibre products profitable. Every stage of Agro-Sustainopreneurship supports its principles, making sure that economic rewards are in line with social and environmental benefits.

Business models that integrate and promote sustainability will have broad aims that benefit both customers and society as a whole. Access to help those who are poor get the services they need. The goal of creating business models for the base of the pyramid was not just to meet their basic requirements but also to provide economic opportunities that would have a beneficial social impact (Yao, 2022). Banana farming is a major sector throughout the world that has a lot of potential. Banana farming creates a lot of trash, such as pseudostems, leaves, and peels. After the harvest, the leaves and pseudostem stay on the field and generate a lot of greenhouse gases. The usual way to do things is for each parent banana plant to produce just one bunch. After that bunch is picked, the parent plant is cut down to make room for a new one to sprout (Abdulai, 2022).

Even though bananas are good for your health and your economy, the value chain is hurt by problems with production and the market, such as low crop yields, restricted access to higher-paying markets, falling prices, poor postharvest management, and low farm incomes. Banana farmers sell their raw bananas for less than the market price because they don't treat them well after harvest. This is because they don't have enough money, can't get to where they need to go, and there aren't any banana cooperatives. Due to conventional farming methods and poor agronomic practices, the amount of bananas produced is steadily going down. There isn't enough coordination amongst banana farmers in the cooperatives, which makes it harder for them to connect with local marketplaces. Also, because of changes in both legal and informal routes for processors and markets, agripreneurs can't sell their commodities in staple food markets at a profit (Hoang, 2023).

Interconnection with SDG Goals

The Sustainable Development Goals (SDGs) are the basis for this research since the suggested Agro-Sustainopreneurial model is quite similar to several of the United Nations' global development goals, which are focused on ending poverty, promoting inclusive growth, and protecting the environment. Using, improving, and selling banana fibre in Tamil Nadu directly helps SDG 1 (No Poverty) and SDG 8 (Decent Work and Economic Growth) by creating new jobs and ways for rural and peri-urban areas to make money. This idea supports SDG 12 (Responsible Consumption and Production) by turning agricultural waste into commodities that can be sold. This follows the ideas of a circular economy, which cuts down on waste and makes better use of resources. In addition, the project supports SDG 5 (Gender Equality) by including rural women in different stages of fibre extraction, processing, and product production. This gives them more power and encourages them to become involved in the economy. SDG 13 (Climate Action) deals with the environmental side of things by recycling banana pseudostems, which decreases carbon emissions and stops methane from escaping from decaying biomass. The appropriate use of local resources helps SDG 15 (Life on Land) by protecting biodiversity and encouraging

good land-use practices. The interconnected SDGs show how the banana fibre initiative could change things, showing how Agro-Sustainopreneurship, which is based in Tamil Nadu and driven by innovation, can help achieve global sustainability goals while also boosting the rural economy.

LITERATURE REVIEW

Using digital technologies, including IoT and social capital, to come up with new ideas may help solve certain problems in the agricultural business. Digitalisation is a way to combine digital and social aspects, which is a hybrid way to solve and ease problems in agricultural value chains. Digitalisation includes things like the Internet of Things (IoT), big data, systems integration, sensors, robotics, always-on connection, augmented reality, machine learning, blockchain, and AI. Internet-based services and e-commerce sites are important for an inclusive digital economy. Researchers say that the digital economy makes for around 3% of all jobs in the globe and 5% of the world's GDP. So, we should think of entrepreneurial innovation that makes systems more adaptable in uncertain and complicated conditions, like an agricultural digital economy ecosystem (Fernando, 2024). Digitalisation has an effect on the AVC, changes it, and causes new things to happen. The economic effects of climate change, population expansion, and advances in science and technology are making the world more difficult to deal with. To solve these problems, transdisciplinary research is needed, which requires cooperation from many different groups. Changes in society make this situation worse because of the realities of the post-COVID-19 pandemic, which have moved data storage from traditional to digital media. As part of the goal of making agriculture more sustainable, people are working to digitise agri-cooperatives, promote traditional farming practices in rural areas, use smart farming, and improve supply chain management. To have long-lasting food systems, you need to be strong (Brooks, 2021). Researchers say that resilience is the ability of a system to keep providing services and adapt to changes that happen all the time. A framework for resilience in the agricultural value chain based on seven ideas: making things more complicated, bringing systems together, getting more people involved, regulating connections, thinking about systems in a flexible way, managing slow variables, fostering learning, and making it easier to provide and get feedback (Yang, 2024).

Climate change, environmental degradation, and the loss of biodiversity have all become worse, forcing Europe to move from a linear economy based on fossil fuels to a circular economy based on biological materials. In the last several decades, European policy agendas and Research and Innovation programmes have worked together with bioeconomy and circular economy production and consumption models to make sure that environmental, economic, and social goals are all in line for climate-neutral and sustainable development (Zhang, 2023).

The bioeconomy, sometimes called the bio-based economy, is the production of renewable biological resources and their conversion, together with waste streams, into things that add value, such food, feed, bio-based products, and bioenergy. To ensure that future generations have enough resources and good living conditions, a change to a bio-based economy is necessary (Simelton, 2021). This will also ensure sustainable development. The ensuring that waste and by Society is a key part of the bio economy, which combines the efficiency of industrial production with the minim the minim waste and byproducts (at least 0).

Smallholder farmers may be able to increase their yield by replacing outdated, inefficient equipment with new, high-tech farming tools. For instance, information and communication technology may lower transaction costs, making it easier for smallholder farmers to access costly farming tools at lower prices, as via tractor leasing services that work like Uber. Technologies like GPS and remote sensing may help farmers work more efficiently and grow more food by accurately finding their farms (Mushi, 2024). Also, internet-connected devices and online service platforms may keep an eye on the conditions for growing crops and keep records of sowing. Also, small farmers may be able to control the health of their soil in a cost-effective way by using tools like sensors and mobile phones together with soil nutrient mapping.

Smallholder farmers may find that decision support systems based on electronic information technology may help them with many parts of farming, such planning, planting, and harvesting. Smallholder farmers may use digital tools like social media, SMS, and radio to learn about how productive their farms are, which helps them make better decisions about what to grow. For example, sending SMS messages with information that has been checked by experts may help farmers make decisions. Also, computerised decision-support tools like Rice advice and nutrition Expert help smallholder farmers on a wide scale use scientific nutrition management practices. Agricultural apps like KRISHI, mPusaKrishi, and Agriapp provide small farmers important advice on how to choose the best crops and protect them from pests (Mapiye, 2021).

Problem Statement

In Tamil Nadu, the banana fibre sector is a mainly underused resource with a lot of potential for social, economic, and environmental growth, especially in rural and peri-urban regions. Even though a lot of bananas are grown in the region and there is a growing demand for biodegradable, sustainable materials across the globe, the usage and sale of banana fibre are still limited and not very well organised. Most banana stems, which are used to make fibre, are thrown away as agricultural waste, which means they can't be used to make money. Additionally, even while some communities do small-scale or artisanal fiber-based work, they lack the integrated infrastructure, technical help, and market access needed for growth. The fact that banana fibre is used in different ways, together with poor optimisation and limited economic opportunities, makes it less likely to be a catalyst for sustainable rural development and a major contributor to the Sustainable Development Goals (SDGs). The problem is made worse by the fact that there is no complete business model that brings together resource use, process improvement,

and product marketing in a way that is socially inclusive and commercially viable (Hank, 2019). Many government projects, NGOs, and businesses have focused on certain aspects of rural empowerment, but few have looked at how to combine the potential of local resources with structured economic paths that align with long-term development objectives. From this point of view, banana fibre is a unique way to fill this gap since it is flexible and good for the environment. There is a big problem since there is no real-world data or examples showing how this kind of fibre may be utilised effectively in a socially entrepreneurial way that has measurable social, economic, and environmental advantages.

At the same time, there is a limited understanding of how different parts of this business model such as levels of resource use, degrees of operational optimisation, and degrees of commercialization affect stakeholder perceptions and real contributions to the Sustainable Development Goals (SDGs). The first results of this study show that each aspect has an influence, but the effects are quite different. For example, commercialisation and utilisation have a far bigger effect than process optimisation. Without a unified plan that brings these parts together and addresses the many levels of community awareness, training, resource availability, and market connection, banana fibre can't reach its full potential for empowering rural areas (Fabregas, 2019).

Objectives

The primary objective of the article is to examine how the utilisation, optimisation, and commercialisation of banana fibre contribute to achieving the Sustainable Development Goals (SDGs) by promoting sustainable agro-industrial practices, enhancing rural livelihoods, and fostering environmental sustainability in Tamil Nadu.

RESEARCH METHODOLOGY

The study gathered a lot of information from both primary and secondary sources. We got secondary data by looking at a wide range of existing literature, such as academic journals, government papers, industry publications, and previous case studies that were relevant to sustainable rural entrepreneurship, agro-based businesses, and banana fibre technologies. These secondary sources helped build a strong conceptual framework and find the key traits that make up the social entrepreneurship model being studied. Secondary data also gave us a better understanding of the banana harvest trends, waste output, and laws that affect the fibre sector in Tamil Nadu.

A systematic questionnaire was issued to a diverse group of people from both rural and peri-urban areas of Tamil Nadu to obtain primary data. The questionnaire was carefully designed to collect quantitative data on a number of areas, such as the usage of banana fibre, operational efficiency, attempts to commercialise, and perceived effects on sustainable development. It also has demographic information to help in segmentation and comparison. The exam included clear, objective questions that used Likert scales to measure how much people agreed or disagreed on important issues. This made it easier to collect data consistently and allowed for full statistical analysis, such as correlation, regression, neural network modelling, and assessing the importance of variables.

The sample comprised people who worked with banana fibre, social companies, farmers, and local business owners. This made sure that the statistics correctly reflected what was really going on and the problems that people were facing. The study used a systematic questionnaire, which made sure that all of the answers were the same, which made the findings more reliable and valid. Using descriptive design with primary and secondary data made triangulation possible, which made sure that the results are both statistically significant and relevant to the situation. This method created a strong framework for looking at how the use, optimisation, and marketing of banana fibre interact with each other and how they all affect rural development and the achievement of the Sustainable Development Goals (SDGs).

This study considers the key variables Utilisation, Optimisation, Commercialisation, and Sustainable Development Goals. Their significance to understand the article is stated as follows

The variables Utilisation, Optimisation, Commercialisation, and Sustainable Development Goals (SDGs) are closely linked to the main idea and purpose of the article "An Innovative Agro-Sustainopreneurs Business Model of Rural and Peri-Urban Empowerment: Utilisation, Optimisation, and Commercialisation of Banana Fibre in Tamil Nadu." Each variable represents a distinct but interconnected facet of the proposed business model, thereby establishing a holistic framework for sustainable rural development via Agro-Sustainopreneurship. The title stresses how resources may change over time, from being used as garbage to being useful for business, while also making sustainability the main goal for long-term empowerment and social and economic inclusion.

Utilisation is the primary variable and the most important part of the Agro-Sustainopreneurial model. Utilisation in this study refers to the intentional collecting and utilisation of banana pseudostems, which are commonly seen as agricultural waste, as a valuable raw material for making fibre. This phase marks the shift from a linear economy to a circular economy by making it easier to put waste materials back into the production cycle instead of throwing them away. It connects to the title by showing how inventive and sustainable the idea is, as people living in rural and peri-urban areas learn to gain value from things that used to be a burden. The study stresses that using these wastes in the right way might help the environment, make more money, and enhance rural living conditions, which would provide the basis for a self-sustaining business ecosystem.

The second variable, Optimisation, refers to the process of making banana fibre extraction and processing more efficient, productive, and high-quality. In the context of the study, optimisation includes not just improving technology but also improving skills, making operations more efficient, and using sustainable manufacturing practices. This step makes sure that turning banana pseudostems into usable fibre is cost-effective, energy-efficient, and can be done on a large scale. This has a clear connection to the article's title, "Innovative," since it

combines modern processes and sustainable technology with traditional rural settings to make production more efficient. Agro-Sustainopreneurs can make high-quality fibre that can be used in numerous commercial applications, including as textiles, handicrafts, and composites, thanks to optimisation. It makes rural people more productive and gives them better rewards, which strengthens the link between sustainable innovation and social and economic success.

The last variable, Commercialisation, is about the article's business model part. The goal is to turn optimal banana fibre into useful products that can be sold and used in profitable value chains. This step is very important since it links environmentally friendly manufacturing with making money. The article talks about how rural entrepreneurs may get into competitive markets by building local and global market linkages, branding tactics, and business networks. The study illustrates the potential for Agro-Sustainopreneurs to transition from subsistence activities to structured enterprises that provide consistent revenue and employment via commercialisation. This phase aligns closely with the "Business Model of Rural and Peri-Urban Empowerment" mentioned in the title, as it demonstrates how economic sustainability may be achieved via innovation and responsible entrepreneurship in the agricultural sector.

Analysis

Table 1: Demographic analysis

Age	Frequency	Percent
Below 25 years	24	11.70
26 - 35 years	58	28.30
36 - 45 years	36	17.60
46 - 55 years	36	17.60
56 - 65 years	27	13.20
Above 65 years	24	11.70
Gender	Frequency	Percent
Male	110	53.70
Female	95	46.30
City	Frequency	Percent
Peri Urban	97	47.30
Rural	108	52.70
Education	Frequency	Percent
10th	46	22.40
12th	52	25.40
Graduation	40	19.50
Post Graduation	13	6.30
Doctorate	54	26.30
Marital Status	Frequency	Percent
Single	48	23.40
Married	135	65.90
Divorced	22	10.70
Annual Income	Frequency	Percent
Below 5 Lakhs	10	4.90
6 - 10 Lakhs	98	47.80
11 - 15 Lakhs	58	28.30
16 - 20 Lakhs	21	10.20
Above 20 Lakhs	18	8.80
Experience	Frequency	Percent
Less than 2 years	4	2.00
2 - 5 years	42	20.50

5 - 10 years	60	29.30
10 - 15 years	43	21.00
More than 15 years	56	27.30
Total	205	100.00

The age group of 26 to 35 years made up the largest group of responders, making up 28.3% of the sample. The 36 to 45 and 46 to 55 age groups were next, each with 17.6%. It is interesting to note that 11.7% of the people who answered were either under 25 or over 65, which shows that people of all ages were represented. This broad variety of ages shows that people of all ages are involved in banana fiber-based social entrepreneurship projects. This shows that skills can be passed down from one generation to the next and that people may share their expertise with each other. There was a fair distribution of gender among the respondents, with men making up 53.7% and women making up 46.3%. This means that a lot more women are involved in the conversation around banana fibre entrepreneurship, which is important for rural empowerment and business models that include everyone. This close to equal number of men and women shows that the study may have led to approaches that are gender-neutral, encouraging both men and women to take part in the value chain.

52.7% of the people who answered were from rural regions, while 47.3% were from peri-urban districts. This shows that the business model being looked at is focused on rural areas. It also confirms the study setting and shows that most of the participants are already part of the social and geographical context of banana fibre production and use. The small rural majority shows how important the concept is for actively involving and changing rural communities. The respondents' educational backgrounds show that they have a lot of different kinds of intelligence. A large number of them, 26.3%, held PhDs, which shows that there were a lot of highly educated people. At the same time, a large number of people in the group had just a 10th-grade education (22.4%) or a 12th-grade education (25.4%). People with undergraduate (19.5%) and graduate (6.3%) degrees added even more information. This educational project shows that the banana fibre concept gets people involved at all levels of academic attainment, from low-level labourers to highly educated or technical experts.

A look at marital status shows that 65.9% of respondents were married, which suggests that families or communities are stable and that people may be able to make decisions together when it comes to money. 23.4% of the people who took part were single, and 10.7% were divorced. The fact that many of the people who answered were married may have an effect on how they think about risk, stability, and whether or not social entrepreneurship is a good way to support a family. The majority of participants (47.8%) earned between 6 and 10 lakhs a year, followed by 28.3% who earned between 11 and 15 lakhs. People with incomes below 5 lakhs made up just 4.9% of the total, while those with incomes over 20 lakhs made up 8.8%. This income distribution shows that middle-income households constitute the backbone of the banana fibre business ecosystem. It means that there is some financial stability and extra money that may be used to invest in new business models, environmentally friendly practices, or new ideas in rural regions.

The data shows a strong mix of both new and seasoned specialists. The group with 5–10 years of experience was the largest, making up 29.3% of the total. The group with more than 15 years of experience came in second, making up 27.3%, while the group with 10–15 years of experience came in third, making up 21%. A small but significant group (20.5%) had 2 to 5 years of experience, whereas just 2% were less experienced, with less than 2 years. This diversity of experience levels shows that the model in issue is appealing to both experienced stakeholders, who provide deep insights, and newcomers, who offer new perspectives.

Table 2: Correlation analysis

Correlations	Utilisation	Optimisation	Commercialisation	Sustainable Development Goals
Utilisation	1	.845**	.891**	.869**
Optimisation	.845**	1	.913**	.857**
Commercialisation	.891**	.913**	1	.904**
Sustainable Development Goals	.869**	.857**	.904**	1

There is a strong link between Utilisation and Optimisation, with a value of 0.845. This means that eating more banana fibre is linked to better optimisation processes, such as new technology, more efficient workflows, and making the most of resources. This strong link shows that the utilisation of banana fibre and the effectiveness of its processing and management are closely linked in practice in order to get the most value out of it. The link between Utilisation and Commercialisation is quite strong, with a score of 0.891. This strong positive link shows that more use directly leads to better business outcomes. The more effectively banana fibre is utilised at the grassroots level, the more likely it is to be a commercial product. This interconnection shows how important it is

for people at the bottom to be involved and grow their skills in order to be successful in business, especially in rural empowerment frameworks.

The strongest link in the matrix, with a value of 0.913, is between Optimisation and Commercialisation. This means that there is almost a straight line between making operations more efficient and being ready for the market and making money. This finding shows how important it is to improve the competitiveness of banana fibre products in commercial markets by making changes to processes and strategies. In social entrepreneurship models, investing in training, adopting new technologies, and improving the value chain will have a direct effect on how well the business does in the market. The connection with the Sustainable Development Goals shows strong positive relationships with all three main components: 0.869 with Utilisation, 0.857 with Optimisation, and 0.904 with Commercialisation. These features show that every part of the banana fibre value chain is important for reaching the Sustainable Development Goals, notably those that have to do with gender equality, environmental protection, rural livelihoods, and sustainable economic growth. The strongest link found was between Commercialisation and SDGs (0.904). This shows that the best way to achieve the main aim of sustainable development is to effectively integrate banana fibre products into the market. It says that commercial viability goes beyond economic achievements and helps achieve broad social and environmental benefits.

Table 3: Regression analysis

Model	Sum of Squares	df	Mean Square	F	p value
Regression	299.845	3	99.948	350.028	.000b
Residual	57.394	201	0.286		
Total	357.239	204			
Coefficients	B	Std. Error	Beta	t	p value
(Constant)	-0.073	0.151		-0.485	0.63
Utilisation	0.33	0.073	0.286	4.527	0.00
Optimisation	0.183	0.093	0.138	1.963	0.05
Commercialisation	0.58	0.092	0.522	6.289	0.00
a Dependent Variable: Sustainable Development Goals					

The regression model summary shows an F-value of 350.028 and a significance level of 0.000, which means that the model is statistically significant at the 1% level. This means that the independent variables have a big effect on the dependent variable, and it's quite unlikely that this outcome happened by chance. The total sum of squares is 357.239, with 299.845 coming from the model (regression sum of squares) and 57.394 coming from the residual (unexplained) variance. The three factors explain a large part of the differences in SDG outcomes. The model's strength is shown even further by the fact that the mean square value for regression (99.948) is substantially higher than the residual mean square value (0.286). The individual coefficients show that the intercept or constant term (-0.073) is not statistically significant (p = 0.63). This means that the model does not provide a useful prediction of the SDGs without the three predictors. The three independent variables do, however, make a big difference in the model, even if they do so in different ways.

Commercialisation is the strongest predictor, with a standardised beta coefficient of 0.522 and a very significant p-value of 0.00. This means that making banana fibre products available for sale has a big effect on reaching SDG-related goals. This might be because it can make money, create jobs, improve supply chains, and bring other benefits to society in rural areas. The unstandardized coefficient (B = 0.58) shows that for every unit increase in commercialisation, there is a 0.58 unit increase in SDG accomplishment, as long as all other parameters stay the same. Utilisation has a statistically significant and positive influence on the Sustainable Development Goals, with a standardised beta of 0.286 and a p-value of 0.00. Using banana fibre resources in a smart and widespread way helps the environment by reducing waste, promoting eco-friendly production, and getting more people involved in circular economy frameworks. The unstandardized coefficient (B = 0.33) shows how important it is for people at the bottom to be involved in resource management.

Optimisation has a beta coefficient of 0.138 and a p-value of 0.05, which means it has a positive effect on the result, although not as strongly as the other two components. Even though its influence is statistically significant, the lower beta shows that improving procedures is important but has a less strong effect on SDG outcomes than the actual use and commercial feasibility of the product. The B score of 0.183 shows that improving optimisation techniques helps SDG performance, but not as much as the other two dimensions. The regression study shows that the three parts of the business model—utilization, optimisation, and commercialization—are statistically significant predictors of sustainable development in rural Tamil Nadu. The most important function is commercialisation, followed by use and finally optimisation. The findings support the model's holistic approach, showing that using banana fibre, improving it, and smoothly integrating it into profitable market channels is the best way to achieve actual rural empowerment and alignment with the Sustainable Development Goals. The results

show how important it is to link the skills of grassroots resources with structured business opportunities for long-term sustainability and impact.

Table 5: Rank analysis

Rank of Utilisation, Optimisation and Commercialisation		
	Frequency	Percent
3	35	17.1
3.5	6	2.9
5.5	30	14.6
8	20	9.8
10.5	20	9.8
17.5	22	10.7
18.5	26	12.7
38.5	46	22.4
Total	205	100

The data shows that 38.5 was the most common rank given to the three criteria, with 46 responses, or 22.4% of the total answers. This indicates that a significant proportion of participants collectively saw these features as very relevant and impactful in the realm of sustainable development and banana fibre use. The high number of scores at this level shows that most respondents want to focus on combining use, optimisation, and commercialisation to get sustainable outcomes.

On the other hand, lesser ratings like 3 (17.1%) and 3.5 (2.9%) show that the people who answered thought these things were quite important. The lower frequencies in these categories suggest that fewer participants deemed these characteristics of low importance, hence reinforcing the consensus that these three dimensions substantially influence the study's thematic framework. The mid-range scores—5.5 (14.6%), 8 (9.8%), and 10.5 (9.8%)—show that the respondents were taking a measured view. They recognised the importance of these traits, but they may have ranked them based on how useful or profitable they were right away.

Ranks 17.5 (10.7%) and 18.5 (12.7%) are interesting because they show that a lot of people put these variables in the upper-middle range. This could mean that they are aware that all three are important, but their effectiveness depends on how well they are integrated into practical sustainable business practices. This aligns with the fundamental framework of Agro-Sustainopreneurship, where utilisation signifies the effective employment of agricultural resources like banana fibre, optimisation relates to the improvement of processing and production, and commercialisation ensures market scalability and economic viability.

The rank distribution pattern shows a positive skew, which means that most people who answered understood the overall importance of these traits. The high number of higher ranks, especially 17.5, 18.5, and 38.5, shows that the people who answered the question saw utilisation, optimisation, and commercialisation as interconnected building blocks that are important for reaching the Sustainable Development Goals (SDGs) related to sustainable industry, innovation, and economic growth. The findings indicate that a purposeful emphasis on these three interconnected attributes might significantly improve environmental sustainability and socio-economic empowerment, particularly in rural and agro-industrial contexts, such as the banana fibre initiatives examined in the study.

Histogram. Mean = 16.088, Std. Dev. = 13.200, N = 205
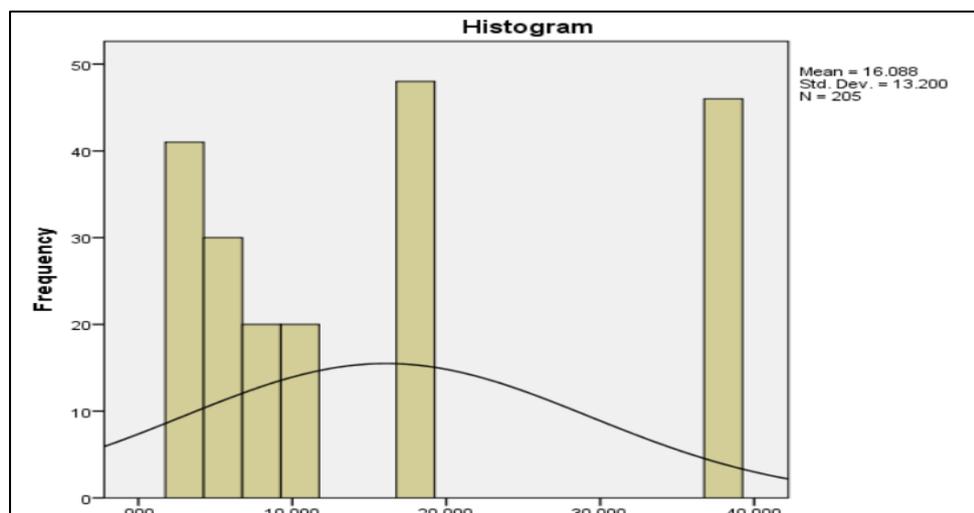
Findings

The findings of the empirical study, which were derived from the perspectives of grassroots stakeholders, reveal that, among the three main constructs utilisation, optimisation, and commercialization utilisation is the most critical aspect in driving sustainable development. In order to develop a social enterprise that is very successful, it is necessary to extract banana fibre from agricultural waste in a manner that is both efficient and ongoing. As a result of the fact that utilisation is of the utmost importance (one hundred percent), the first step in the process of creating value is to see waste not as a responsibility but rather as a potential resource. The supply of pseudo-stem debris represents an untapped potential in the state of Tamil Nadu, which accounts for a significant portion of the banana producing industry. Through the use of simple and economical techniques, the transformation of biomass into fibre that can be utilised generates employment possibilities, particularly for women and impoverished populations. This, in turn, improves the quality of life in rural areas and contributes to the preservation of the environment.

The commercialisation of the model, which has a significantly high normalised significance (97.7%), is an essential component that plays a significant role in determining its long-term survival. The almost equal focus placed on utilisation draws attention to the fact that the production of fibre is insufficient in the absence of a powerful market link that can assimilate the end items. According to the findings of the study, consistent revenue may be possible via the proper marketing of banana fibre, especially in companies that are conscious of the environment, such as the textile, handicraft, and packaging industries. It is possible that the value of fiber-based products might be increased by the implementation of commercialisation activities such as branding, innovation in packaging, strategic alliances, and integration of e-commerce. The success of commercialisation is contingent on the successful completion of a number of obstacles, including the maintenance of product consistency, the promotion of awareness among mainstream customers, and the provision of enough financial aid to rural firms. In spite of the fact that efforts are already being made to expand into new markets, the findings of the study show that further institutional assistance, notably in the form of subsidies, export incentives, and incubation services, is required in order to have a more significant impact. The process of commercialisation need to be seen not only as a sales activity but rather as a strategic function that encompasses branding, innovation, and the integration of value chain components (Mehrabi, 2021).

Optimisation, albeit displaying a reduced relative relevance of sixty percent, is essential in order to ensure that the processes of utilisation and commercialisation are both efficient and scalable. In the context of this discussion, the term "optimisation" refers to the process of improving the operational processes that are associated with the extraction, processing, and storage of banana fibre. The findings of the study indicate that the process continues to be labor-intensive, time-consuming, and prone to quality differences in the absence of mechanised support and organised training programmes within the industry. Since this is the case, optimisation should not be seen as a secondary concern but rather as an essential factor that contributes to the achievement of success in both upstream and downstream operations. It is possible that via investments in the dissemination of technology, the standardisation of production processes, and the development of local capacity, the whole fibre ecosystem might see an increase in both productivity and cost-effectiveness. Additionally, optimisation may decrease the amount of resources that are wasted and the amount of energy that is used, so aligning the business model with the larger sustainability goals.

The core of the proposed business model for social entrepreneurship is comprised of the combination of the three elements, which are utilisation, optimisation, and commercialisation. Based on the findings, it is clear that in order for rural empowerment to be both long-lasting and successful, these specific components need to work together. Through this triadic relationship, job opportunities are created, community ownership is encouraged, environmental responsibility is improved, and economic inclusion is ensured throughout the process. Furthermore, the model's congruence with other Sustainable Development Goals specifically, SDG 1 (No Poverty), SDG 5 (Gender Equality), SDG 8 (Decent Work and Economic Growth), and SDG 12 (Responsible Consumption and Production)—increases its relevance in the ongoing debates on development policies and practices. The study makes a critical acknowledgement of the model's shortcomings, which include fragmented supply chains, a lack of business skills among rural women, and poor institutional coordination. These shortcomings have the potential to interfere with the model's capacity to scale if they are not adequately addressed.

CONCLUSION

In conclusion, the findings of the study indicate that banana fibre, when used via a methodology of social entrepreneurship that is well-organized, had a substantial potential to act as a catalyst for the development of rural areas. Utilisation, optimisation, and marketing are three fundamental interactions that not only provide economic gains but also promote social inclusion and environmental sustainability. These three interactions are crucial to the economy. According to the findings of the study, there is a need for particular policy interventions, collaborative partnerships, and capacity-building activities in order to improve and replicate this model in other regions of India and the Global South that are bountiful in resources but economically disadvantaged.

Limitations

There are several limitations that are acknowledged in the research, and these limitations may have an impact on how the results are interpreted.   Due to the fact that the data obtained is dependent on the opinions of the

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respondents, there is a chance of response bias or subjective interpretation. Despite the fact that the sample size is sufficient for exploratory research, it is possible that it does not effectively reflect the larger population that is involved in the use and marketing of banana fibre across a number of locations in Tamil Nadu. Furthermore, external variables such as changes in the market, technical differences, and variations in regional policy were not thoroughly investigated, which may have an impact on the generalizability of the findings. The data used in the research are self-reported, which means that there is a possibility that the favourable results might be inflated owing to social desirability bias. In spite of these constraints, the results provide significant insights into the interwoven roles that commercialisation, optimisation, and utilisation play in the process of accomplishing the Sustainable Development Goals.

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