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Developing a Forestry Business Model Through the Business Model Canvas: A Case Study in Gerlang Village, Batang Regency, Central Java

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ABSTRACT

At the local level, social forestry is a key strategy for implementing sustainable forest management that aims to reduce poverty, empower local communities, and improve forest conditions. Granting forest area management permits to local communities requires good business development planning. This study used the business model canvas framework to develop a new business model. The result showed that a new business model was developed by considering the benefits of vegetables, arabica coffee, and tree carbon storage as the value propositions. The customer segments were housewives, restaurant owners, coffee shop owners, and CO_2-emitting companies. The products were distributed through trader networks and voluntary carbon market mechanisms. Farmers established direct relationships with trader networks. Revenue streams were derived from the sales of fresh potatoes, carrots, leeks, chilies, coffee beans, and carbon credits. This business model required an area, irrigation equipment, farming equipment, seeds, fertilizers, laborers, and tree biomass measuring tools. Key activities included farming, measurement, and calculation of carbon storage estimates. The partners in this business model were community organisations and local government agencies. The cost structures were investment, operational farming, and costs associated with measuring and calculating carbon storage.

Introduction

Sustainable forest management looks not only at an economic perspective but also at an environmental and social perspective [1,2]. This paradigm shift is also reflected in policies in Indonesia's forestry sector [3,4]. Indonesian Government Regulation No. 23 of 2021 on multiple forest businesses is one policy for implementing multi-forestry business activities, consisting of area utilization, timber, non-timber forest product utilization, and environmental service utilization to optimize forest areas in protected forests and production forests.

Social forestry is a key strategy for implementing sustainable forest management at a local level. The government allocated 12.7 million ha of forest area to be managed by local communities. This strategy aimed to reduce poverty, empower local communities, and improve forest conditions. Gerlang Asri Social Forestry Business Group is one of the recipients of the social forestry permit. It was granted because of a tenure conflict between Gerlang and Banjarnegara farmers. It occurred in the limited production forest area owned by Perhutani. The permit form is the Forestry Partnership, which allows Gerlang farmers to manage the area independently. Gerlang Asri Social Forestry Business Group is still classified as a Blue class, where this class is newly formed and does not yet have a management plan. Therefore, an innovative business development plan is required to ensure sustainable management. Future forestry management requires diversification

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strategies and the development of innovative activities [5,4]. Business model innovation is needed to increase economic profit and community welfare, and to help preserve the environment.

Business models have recently been widely discussed among entrepreneurs, managers, and academics. A business model is a simple description of the elements of value proposition, value creation and delivery, value capture, and interactions between the elements in a business unit [6]. The business model canvas (BMC) has been widely used by practitioners and scientists [7,8], making it an ideal foundation for sustainable business model development [9,10]. Therefore, this study sought to develop a new business model for agroforestry businesses in the social forestry area of Gerlang Village using the BMC framework.

Materials and Methods

Location and Time

This study was conducted from March to July 2023 in Gerlang Village, Blado District, Batang Regency, Central Java Province. The main research location was the social forestry area, which is distributed across Wonopriyo Hamlet and Kradenan Hamlet (Figure 1). Farmer respondents were also people who lived in these two hamlets.

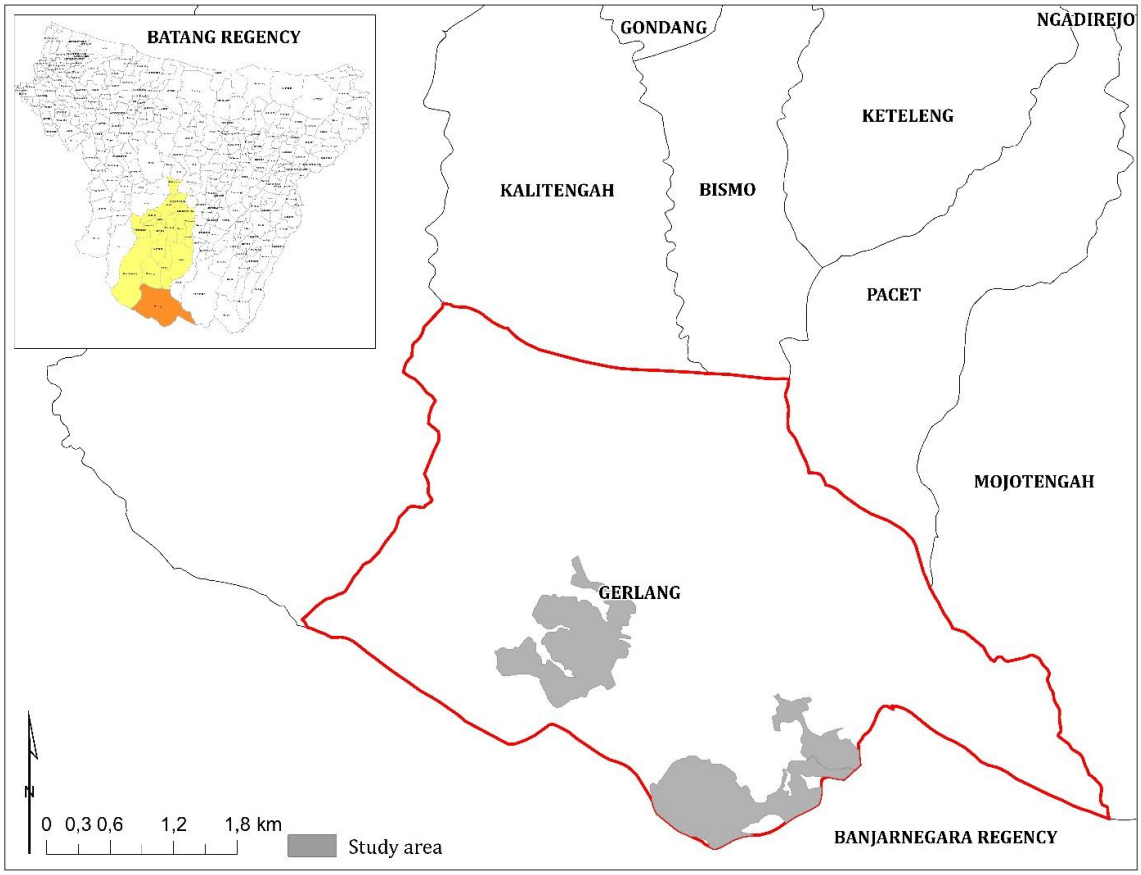

Figure 1. Research location.

Data Collection

The approach used in this study was the nine elements of BMC to develop a new business model for forestry businesses on the social forest area in Gerlang Village. The data were both quantitative and qualitative. Data were obtained from field observations, questionnaires, in-depth interviews, and forum group discussions (FGDs). Interviews were conducted with the social forestry division of Pekalongan Timur Forestry Management Unit, Blado Forest Management Unit Office, Gerlang Asri Social Forestry Business Group, and 100 farmers and communities involved in the forestry business on the social forestry area in Gerlang Village. The sample size was determined using the Slovin formula for a population of 552 registered farmers. The sample selection criteria used were registered farmers actively working in social forestry areas. The questionnaires were adapted to the guiding questions developed by Purnomo and Puspitaloka [11] to explore

the potential for business development at research sites. The collected data were used to formulate nine business model elements, including customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partners, and cost structures [12].

Data Analysis

The analytical methods used in this study include area cover analysis, existing business condition analysis, business development potential analysis with BMC, carbon stock estimation analysis, and financial feasibility analysis of the formulated business model. Area cover analysis aimed to determine the distribution of research locations and areas of several cropping patterns applied by farmers. Furthermore, an analysis of the existing business model was carried out using descriptive qualitative analysis based on the results of field observations and interviews. The results obtained were in the form of an overview of the forestry business running in the research location. The next analysis explores the potential for business development based on the BMC framework. Data from interviews and FGDs were formulated and mapped into nine elements of the BMC: customer segments, value propositions, channels, customer relationships, revenue streams, key resources, key activities, key partnerships, and cost structures. The analysis of each element is presented with the results of primary data processing and is supported by previous studies [13].

Value propositions describe the products and services that generate value for customer segments. Value proposition is the basis of customer attraction. A value proposition consists of products and services that support product offerings. This research creates value propositions from commodities found in the research location, such as vegetable horticulture crops such as potatoes, carrots, leeks, chillies, pine, and *Schima wallicii* trees. Because trees in social forestry areas cannot be cut down, the potential carbon sequestration value is chosen as one of the value propositions.

Estimation of plant biomass using non-destructive techniques or indirect estimation using an allometric formula. The allometric formula used was adjusted according to the type of plant and diameter found in the research location. The carbon storage value was estimated from the tree biomass above and below the ground. The variable used in the formula is diameter at breast height (DBH). The carbon storage value was calculated by multiplying the total tree biomass by a multiplying factor. The calculation of above and below ground biomass of pine was calculated using Equation 1 and Equation 2. Then the above and below ground biomass of *S. wallicii* was calculated using Equation 3 and Equation 4.

Pine

$$\mathrm{AGB} = 0.0936(\mathrm{D})^{2.4324} \quad (1)$$

$$\mathrm{BGB} = 0.0103(\mathrm{D})^{2.6036} \quad (2)$$

Schima wallicii

$$\mathrm{AGB} = 0.178(\mathrm{D})^{2.222} \quad (3)$$

$$\mathrm{BGB} = \exp\,(\text{-}1.0587 + 0.8836 \text{ x } \ln \mathrm{AGB}) \quad (4)$$

Where AGB is the aboveground biomass (kg), BGB is the below-ground biomass (kg), and D is the diameter at breast height (cm) [14].

Then estimating the carbon stock of the trees. According to Ramadhanti et al. [14], at SNI 7724:2011, the percentage of carbon content in wood, litter, and dead wood was 47%. Then, to estimate the carbon in trees, use Equation 5.

$$\mathrm{C} = 47\% \text{ x } \mathrm{TB} \quad (5)$$

Where C is tree carbon (kg), TB is total biomass (kg), and 47% is the carbon constant according to the SNI 7724:2011.

The next step is estimation of carbon sequestration. To calculate the CO_2 sequestration, it is necessary to convert the molecular weight of C to the molecular weight of CO_2. Equation 6 is used as follows:

$$\mathrm{CO_2\ uptake} = \frac{\mathrm{Mr\ CO2}}{(Ar\ C)\ C} \quad (6)$$

where Mr CO_2 is the relative mass of the CO_2 molecules (44), Ar C is the relative mass of C atoms (12), and C is the carbon mass (kg) [15].

The last step is calculating the economic value of CO_{2eq} sequestration. Based on predictions from the Asia-Pacific Integrated Model/Computable General Equilibrium (AIM/CGE), the price of carbon is estimated to reach US$ 19 per tonCO_{2eq}. If the exchange rate of US$ 1 is equivalent to IDR 14,650, the exchange rate of carbon sequestration per ton CO_{2eq} to rupiah is IDR 278,350 [16].

Customer segments differentiate customers based on similarities in behavior and needs. A product (good or service) is said to have value if customers or people consume or utilize it. Customers are the most important aspect of a business. The existence of customers significantly affects the sustainability of a business. Companies need to group customers based on similarities in behavior and needs to fulfill customer needs and satisfaction. Channels describe how producers deliver value propositions to customers. One way to reach customers is to know the commodity supply chain. A supply chain is the integration of processes from multiple business entities (groups/independents), including the procurement of raw materials, processing into finished/half-finished materials, and delivery to end users, including agricultural products [17].

Customer relationships describe producer relationships with customers. It can be formed based on underlying motivations such as customer acquisition, customer retention, and sales boosting (upselling). Customer acquisition is the company's motivation to acquire new customers, both those who come from competitors and those who have not previously used the products offered by the company. Customer retention is a company's motivation to maintain customers so that they do not switch to other producers. Boosting sales (upselling) is the company's motivation to get customers to buy more of its products.

Revenue flows describe the flow of cash gained from selling the products. There are two types of revenue streams based on price mechanisms: fixed-price and dynamic price mechanisms. A fixed-price mechanism is based on static variables including the price list, product features, customer segments, and volume. Meanwhile, the dynamic price mechanism changes according to the market conditions. The market conditions that can affect prices include negotiations, yield management, real-time markets, and auctions.

Key resources are the most important for a producer to be able to run its business model. The key resources owned by the producer will enable it to create and offer value propositions to customers, gain markets, and generate revenue. Essentially, key resources can be owned entirely by the producer or working with key parties. Key resources are determined by the form of the business model to be implemented. Key resources can be human, financial, physical facilities, and intellectual.

Key activities include the main activities performed by a producer to execute its business model. Key activities are necessary for businesses to create value propositions, gain markets, and earn revenue. Key activities vary according to the business model implemented. Key partners are other parties that work with producers to achieve their goals. This block describes the relationships between partners and supplier networks that make the business model work. Producers establish relationships with partners to reduce risk and obtain resources. The types of partnerships run by producers include strategic alliances between non-competitors, strategic partnerships between competitors, joint ventures to develop new businesses, and buyer and supplier relationships to ensure the availability of resource supplies.

Cost structures include all the costs incurred to run the business model. The cost structure describes the main costs that support the operation of a business model. The components of the cost structure include the costs of creating and enhancing value, maintaining customer relationships, and costs to earn revenue. Calculations of the business model are performed after analyzing key resources, key activities, and key partnerships.

Result

Agroforestry Business in Social Forestry Area

The research site was located in Gerlang Village, Blado District, Batang Regency, Central Java. It is directly adjacent to Batur District, Banjarnegara Regency, and Central Java. The geographical condition is in a mountainous area with an altitude of 1,800–2,000 meters above sea level. The area is included in the cool climate zone according to the Junghuhn Climate classification, with vegetation types of pine and *S. wallicii* trees, horticultural plants, arabica coffee, tea, and quinine. Legally, the research site is located in the Terbis Block, which is a limited-production forest area with social forestry utilization. The total area of the research site was approximately 206 ha, spread across two hamlets, Wonopriyo and Kradenan (Figure 2). The land utilizations in both locations were fields of horticultural crops such as potatoes, carrots, leeks, and chilli. There are also pine, *S. wallicii*, and arabica coffee.

(a) (b)

Figure 2. Photographs of the research location in the Terbis Block: Wonopriyo Hamlet (a) and Kradenan Hamlet (b).

One of social forestry area utilization is by implementing an agroforestry system. However, this system had not been implemented by farmers. There were 60% of farmers who had implemented agroforestry. There were three types of planting patterns found in the location: (1) trees, arabica coffee, and horticultural crops; (2) trees and horticultural crops; and (3) only horticultural crops. Based on the results of the area cover analysis using satellite imagery and ground checks, the percentage area of each cropping pattern can be determined. The area that applied the cropping pattern of trees, arabica coffee, and horticultural crops was 26%. The area with a planting pattern of trees and horticultural crops accounted for 35%. However, those who only planted horticultural crops amounted to 26%. The remaining 12% were bush and open areas.

Businesses run by farmers in the social forestry area in Gerlang Village have a main value proposition for horticultural products. Horticulture is the main commodity cultivated for generations by the people of Gerlang Village. It was a commodity that provided the largest income to farmers. Vegetables can grow well in a research location based on environmental suitability. The farming system applied was traditional farming, with production activities that include area cultivation, planting, maintenance, harvesting, transporting, and selling crops. The main resources include areas, huts, irrigation instruments, agricultural equipment, seeds, fertilizers, and laborers. Production costs included the costs of area cultivation services, procurement of seeds, fertilizers, pesticides, watering, weeding, harvesting, and transportation services. In transporting fertilizers and crops, farmers partnered with the Ojek Tani community. The revenue streams from this business model included fresh potatoes, fresh carrots, fresh leeks, and fresh chilies. These products were channelled through a network of traders to local markets and markets outside the region. The interactions or relationships between farmers and traders included obtaining information on crop yields directly by telephone, obtaining lower prices, and providing capital loans for farming businesses. The customer segment for this product was those who buy vegetables in local markets or out-of-region wholesale markets. Some vegetable consumers found in local markets included housewives, food stalls, and restaurant owners.

Analyze Business Development Potential with the BMC

The analysis was conducted by formulating and mapping the data from interviews and FGDs with stakeholders into the nine elements of the BMC. The analysis was presented together with the results of primary data processing and was supported by the literature.

Value Propositions

The goal of social forestry area management is to pay attention to environmental factors. The agroforestry system is an option for area utilization in the social forestry area of Gerlang Village. It consisted of a combination of timber, coffee, and horticultural crops. This combination was widely applied in rural areas with the main livelihood of the community being farmers [18–20]. The proposed values of social forestry area management in Gerlang Village included horticultural crops, such as potatoes, carrots, leeks, chillies, pine, *S. wallicii*, and arabica coffee. Horticulture was chosen as the main commodity because it has been cultivated by the people of Gerlang Village for generations. It was a commodity that provided the largest income to farmers. Vegetables can grow well in a research location based on environmental suitability. Based on the interview results, 100% of respondents chose to plant horticulture. The farming business used an intercropping system that adjusted the planting distance (Table 1) to obtain optimal area utilization.

Table 1. Plant spacing and number of plants.

	Type of commodity	Planting position	Plant spacing (m)	Number of plants
A.	Horticulture			
	Potatoes	Beds	0.5 × 0.5	2,585
	Carrot	Beds	0.25 × 0.25	5,169
	Leek	Bed edge	0.25 × 0.25	2,067
	Chilli	Area edge	1 × 1	203
B.	Plantation			
	Arabica coffee	Area	3 × 3	277
C.	Tree			
	Pine	Area	6 × 6	69
	Schima wallicii	Area	6 × 6	69

Note: Calculation based on 0.25 ha of area; Source: Primary data 2023 (processed).

Based on interviews, many vegetable crops were cultivated by farmers, but the main commodity was potatoes because of the high economic value in the market. During data collection, the price of potatoes from farmers reached IDR 10,000–14,000 per kg, carrots reached IDR 3,000–7,000 per kg, leeks reached IDR 5,000 per kg, and chilies reached IDR 7,000 per kg. However, farmers' operational costs for potato cultivation were high. Therefore, other horticultural crops with lower production costs, such as carrots, leeks, and chilies, were planted to provide additional benefits to farmers. Carrots were grown as rotation crops, the selling price in the market was quite good, and the seeding method can be produced by farmers themselves. Leek and chili were planted as peripheral crops; therefore, maintenance costs were included in the main crop. In addition, these two commodities can be harvested several times from a single plant. Arabica coffee was planted in the field at a distance of 3 × 3 m. It was chosen because the economic value of arabica coffee beans is quite high in the market. In addition, there are far fewer Arabica coffee farmers than robusta farmers. Pine and *S. wallicii* trees were chosen because they are commonly found in research locations and grow without intensive care. Moreover, the presence of these hardwood plants can provide ecological benefits to the mountainous areas of Gerlang Village. Figure 3 shows the illustration of the planting pattern.

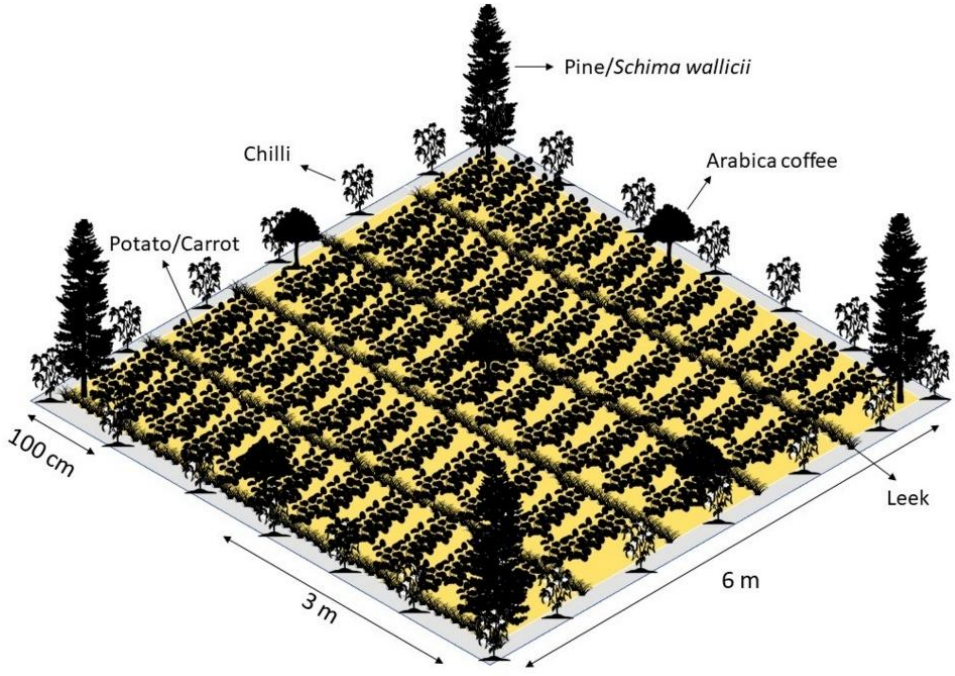

Figure 3. Illustration of the agroforestry model of the social forestry area in Gerlang Village.

The potato variety that was widely planted by farmers was Granola L. This variety has a harvest period of 100–115 days with a potential yield of 5–6 tons 0.25 ha^{-1} [21]. Harvested potatoes were divided into several quality grades. The purpose of quality grading is to separate fruits with similar quality and size. Some grades of potato products include S-grade, A-grade, B-grade, and C-grade. The S-grade has the best quality with a large size, smooth fruit skin, and bright yellow color. This grade of potato usually has the smallest percentage

of the total harvest. A-grade potatoes have the same quality as S-grade potatoes, but are smaller in size. A-grade potatoes usually have the highest percentage of the total harvest. B-grade potatoes have a quality below that of A-grade, medium fruit size, and less smooth skin. It usually has almost the same percentage yield as A-grade. C-grade potatoes have the smallest fruit size. These potatoes were not sold, but stored in storage huts for 2–3 weeks. These potatoes were used as seedlings for the next planting period.

In addition to potatoes, crop rotation was performed using carrot commodities. The purpose of crop rotation is to prevent the development of soil disease pathogens and to break the life cycle of plant disease pests [22,23]. The harvest period for carrots and potatoes is four months. Crop rotation occurred after the first potato-planting period. The average carrot yield was 3–5 tons 0.25 ha^{-1}. The grading process was also conducted on carrot crops for marketing purposes. Carrots with bright orange color, straight and unbranched, not rotten, and not woody, with a diameter of 3–4 cm and length of 14–20 cm are given A-grade. B-grade carrots have the same criteria as A-grade carrots but are smaller in size. Carrots that do not meet these criteria are classified as bulky or damaged carrots.

Intensive agricultural area management with an intercropping system has many benefits, including increased productivity. Leek and chilli were planted as edge crops. Although only as edge crops, the yields of leeks and chillies are profitable. The price of leeks reached IDR 5,000 per kg and the price of chillies reached IDR 7,000 per kg. In one cropping period, 1–2 quintals of leeks and 100 kg of chillies can be obtained. Leeks, as an edge crop, are also useful as growth inhibitors for potato pests [24–26]. Although they do not receive intensive care, edge crops can provide additional benefits during the waiting period for potato and carrot harvest.

However, Arabica coffee plants are not widely planted by farmers. The coffee plants found in the location had a tree height of 50 cm from the ground with short-pruned branching. Because of these conditions, few coffee beans have been produced. Thus, harvested coffee beans are only utilized for farmers' household needs. However, because the market potential of Arabica coffee beans is quite good, coffee plants are proposed to be cultivated. In addition, the presence of coffee plants in sloping social forestry areas is beneficial as a runoff reducer.

The pine trees on site were mostly 5 and 15 years old. The average diameter of five-year-old pine trees was 3–5 cm. While 15-year-old pine trees had an average diameter of 10–12 cm. The *S. wallicii* trees at the site are, on average, five years old with a diameter of 3–5 cm. Most *S. wallicii* trees come from stem cuttings made by farmers themselves, so tree growth tends to be uneven. To date, there has been no special use of *S. wallicii* and pine trees. Farmers use them only as poles to tie irrigation pipe trunks. Therefore, the potential value of carbon storage (Table 2) in social forestry areas can be an alternative utilization [18,27].

Table 2. Estimated mean ± standard deviation of tree carbon storage on social forestry area in Gerlang Village.

Trees	Age group (years)	AGB (kg per tree)	BGB (kg per tree)	C (ton 0.25 ha^{-1})	C (ton ha^{-1})
Schima wallicii	5	2.27 ± 0.22	0.35 ± 0.00	0.20 ± 0.11	0.31 ± 0.03
Pine	5	3.01 ± 0.27	0.42 ± 0.04	0.18 ± 0.08	0.45 ± 0.04
Pine	15	40.83 ± 0.14	6.89 ± 0.21	3.33 ± 1.51	6.23 ± 0.18

Customer Segments

The customer segment consumes or uses the value proposition created by the producer**.** The customer segment of the vegetable farming business in Gerlang Village is classified as an open market, namely, consumers of the value proposition created can come from anywhere without distinguishing the specific needs of their customers. Production activities are carried out based on the market demand for vegetables. Indonesian potato consumption has reached 2.20 kg per capita per year [28]. It has increased by 9% since 2013. Gerlang Village's vegetable products are sent to markets outside the region. S and A grades potatoes have customers in the Jakarta, Bogor, Sumatra, Kalimantan, Semarang, and Yogyakarta markets. B-grade potatoes and carrots have customers in local markets such as Batang, Bandar, and Limpung. While C-grade potatoes are not sold, they are stored and used as seeds in the next planting period. There are specific criteria for potato seedlings, one of which is the fruit size. The S, A, and B grades are too big for seedling purposes. The market demand for leeks originates from East Java and Bali. The chillies' commodities have demand from the Bandung market.

The emergence of coffee shops in Batang Regency in recent years has opened new opportunities for coffee farmers to sell their yields. Several coffee shops are located in the natural tourism area of the Blado sub-district. Based on the results of an interview with one of the largest coffee shop entrepreneurs in Batang Regency, the coffee beans needed for their businesses reached 85 kg per month. As much as 60% of coffee

bean needs are still supplied from outside the city, such as Pekalongan and Yogyakarta. Meanwhile, coffee beans supplied by local farmers come from Tombo and Kembanglangit villages. He said that local coffee bean production is still relatively low, so they have to buy from outside the area to fulfill their production needs. The coffee shop owners also said that they were open to partnering with new coffee farmers.

Trees in social forestry are a must presence because the status of the location is forest area, so that the forest function has to be maintained, although in the form of agroforestry. One of its benefits is their ability to store carbon. The opportunity to utilize the value of carbon storage is supported by the opening of the carbon exchange market for Indonesian carbon trading. Therefore, social forestry has the opportunity to participate in the Indonesian carbon market as a carbon stock provider. Carbon stocks owned by social forestry areas can be sold in the form of carbon credits [29] through cooperative programs to reduce CO_2 emissions. Cooperation and emission reduction projects were conducted with CO_2-emitting companies. Energy companies such as power plants are one example of companies that emit CO_2 from the use of coal fuel. The estimated emissions released by power generation companies range from 31.81–99.71 kt per day [30].

One of Indonesia's power plant companies is Batang Regency. The company, operated by PT Bhimasena Power Indonesia, has been in operation since August 2022. During its journey, the company's responsibility to the community and environment has been shown through the Corporate Social Responsibility (CSR) program in several villages in Batang Regency [31,32]. An environmental conservation cooperation program can be established through the CSR program of PT Bhimasena Power Indonesia by involving parties from the Pekalongan Timur Forest Management Unit and Batang governments. In addition to PT Bhimasena Power Indonesia, Batang Regency has the Batang Integrated Industrial Estate which has been occupied by several companies such as PT Nestle, PT KCC Glass Indonesia, PT Unipack Plasindo, and PT Rumah Keramik Indonesia. The results of an interview with one of the parties from PT Nestle indicated that the company opened up opportunities to partner with Gerlang Asri Social Forestry Business Group through activities to improve community welfare or environmental preservation.

Channels

The main obstacle to implementing agroforestry systems is their profitability. In the current economic system, agroforestry with high biodiversity has difficulty achieving the same level of profitability as monoculture systems [33]. It reflected in the preference of smallholders to switch from agroforestry to more profitable monocultures [34]. Therefore, improved product commerciality and integration into rural value chains are required. One such example is the existence of marketing channels. It describes how producers deliver value propositions to customers. Marketing channels are several marketing institutions that can deliver products from producers to consumers. Marketing institutions can consist of traders, middlemen, retailers, wholesalers, agents, brokers, auction houses, distributors, processors, and credits [17,35].

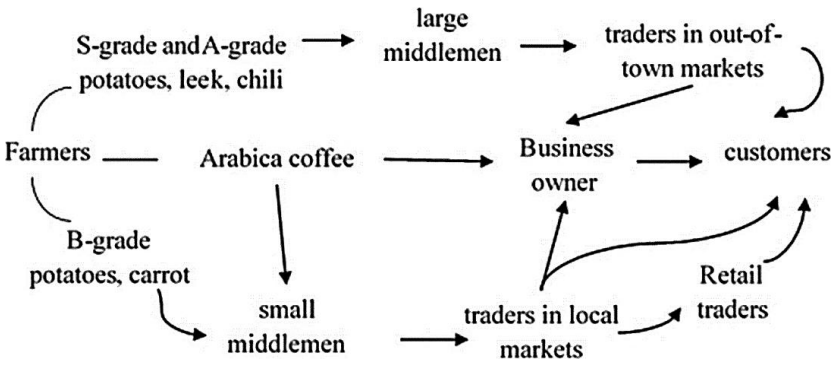

Figure 4. Vegetable and coffee bean supply chains in Gerlang Village.

The trader network in Gerlang Village includes large middlemen, small middlemen, traders in out-of-town markets, and traders in local markets (Figure 4). S-grade and A-grade potato traders send potatoes to the out-of-town wholesale market five times a week. One shipment can carry up to seven tons of fresh potatoes. B-grade potatoes are delivered to the local market every day, with a total of three tons of fresh potatoes in one delivery. Carrot traders usually deliver 6–7 tons of fresh carrots to the local market every day. Leek collectors send no less than five tons of fresh leeks to East Java and Bali every day. Meanwhile, chilli collectors only make deliveries twice a month because of limited harvests from farmers. Vegetable selling price agreements are determined by transactions between the farmers and traders. Information about the selling

price of vegetables is spread by word of mouth among farmer groups in Gerlang Village. Based on the data during the research, the price margin taken by the trader was IDR 500–1,000 per kg. Arabica coffee beans can be distributed by intermediary traders or directly to coffee shops. The types of coffee beans that can be distributed by intermediary traders are berries and green beans. Roasted coffee beans can be sold directly to coffee shops.

The value of carbon storage from trees in social forestry areas can be converted into a carbon sequestration value (1 tCO_{2e}). This value can be exchanged for carbon credits if it passes the verification and validation processes by an authorized independent institution. Carbon credits are certificates awarded for efforts to control or reduce carbon emissions [36]. Carbon credits such as the Indonesia Climate Exchange (ICX) can be traded through carbon exchange markets registered in Indonesia. There are two types of carbon exchange market: mandatory and voluntary [37]. The mandatory market is the buying and selling of carbon credits, based on the obligations imposed by the government for national greenhouse gas emission reduction programs. The voluntary market involves buying and selling carbon credits based on the desire to reduce greenhouse gas emissions, not because of government policies for greenhouse gas reduction [38]. The proposed project for carbon sequestration in this business model is a form of voluntary cooperation or CSR with CO_2-emitting companies, so the sale of carbon credits can be through a voluntary market mechanism [29]. The researcher interviewed one of the parties from a multinational company in Batang Regency regarding its potential for cooperation with Gerlang Asri Social Forestry Business Group. They stated that they were open to establishing cooperation through CSR programs by submitting proposals to the company.

Customer Relationships

There was no direct interaction between farmers and consumers of fresh vegetables. The relationship between farmers and middlemen. Farmers with regular middlemen customers will provide information regarding their yields directly by telephone. Some farmers also receive benefits from their customers in the form of capital loans for farming. On the other hand, with capital loans, farmers cannot bargain at higher prices. Thus, most farmers prefer bank loans. Gerlang Asri Social Forestry Business Group can assist in the form of crop distribution advice into the trader network. Gerlang Asri Social Forestry Business Group can collect and process farmers' coffee bean yields before they are distributed to customers. Meanwhile, the emission reduction program is related to CO_2-emitting companies. In the emission reduction cooperation project, Gerlang Asri Social Forestry Business Group was assisted by the Forestry Management Unit to provide periodic reports on the development of trees and carbon storage values to the company. Meanwhile, the company also provides reduced program costs.

Revenue Streams

The revenue streams were generated from a financial feasibility test of planting scenarios in social forestry areas using several assumptions. First, the price of goods used in the calculation is the price level at the farm level at the time of research. Second, the discount rate used is the interest rate from the KUR BRI Wonosobo of 7% per year. This type of loan is widely used by farmers in Gerlang Village. Third, the period used for future projections was 20 years. It was determined by considering the value of economic benefits that can be obtained from each commodity. The economic benefits of vegetable commodities can be harvested after 3–4 months. The benefit value of Arabica coffee can be obtained every year after the plant reaches the age of five years. The value of the carbon sequestration benefits of pine and *S. wallicii* trees can be obtained every five years. Last, the impact of tree growth on vegetable productivity was not considered because of limited research time.

The size of the area cultivated by farmers in the social forestry area uses the plot unit. One plot was approximately 0.25 ha. In one year, potatoes are harvested 2–3 times with an average volume of 1.5–3 tons in one planting period. Carrots were harvested once, with an average volume of 1.5–3 tons. Leeks can be harvested up to three to five times per year, with an average volume of 100–200 kg. Chillies can be harvested 2–4 times, with an average volume of 100 kg. Arabica coffee beans can be harvested after the plant reaches five years of age. Furthermore, harvesting can be performed twice a year with a volume of approximately 139 kg per harvest period. During data collection, the price of potatoes at farmer levels reached IDR 10,000–14,000 per kg, carrots reached IDR 3,000–7,000 per kg, leeks reached IDR 5,000 per kg, and chillies reached IDR 7,000 per kg. Meanwhile, arabica coffee beans in the form of green beans reached IDR 50,000 per kg.

The carbon storage value of trees can be converted into carbon credits and sold in the carbon exchange market. Based on predictions from the Asia-Pacific Integrated Model/Commutable General Equilibrium (AIM/CGE), carbon prices are estimated to reach US$ 19 per ton CO_{2eq}. If the exchange rate of US$ 1 is

equivalent to IDR 14,650, then the exchange rate of carbon uptake per ton CO_{2eq} against rupiah is IDR 278,350 [38]. Table 3 shows the list of average sources of income annually received from each cultivated commodity.

Table 3. List of average sources of income annually received from each commodity.

	Source of income	Amount of income per year (IDR)	Percentage (%)
A.	Fresh vegetables		
	Potatoes	72,105,320	62.20
	Carrots	25,236,862	21.77
	Leeks	4,120,304	3.55
	Chillesi	1,420,897	1.23
	Arabica coffee beans	9,246,994	7.98
B.	CO_{2eq} uptake value		
	5 years old *Schima wallicii*	205,404	0.18
	5 years old pine	186,791	0.16
	15 years old pine	3,394,202	2.93
	Total	115,916,774	100

Note: Calculation based on 0.25 ha of area; Source: Primary data 2023 (processed).

Key Resources

Key resources are those needed to perform key activities in the business model. The key resources required for farming activities in Gerlang Village are still traditional, such as the use of conventional agricultural tools and human labor. Key resources owned by farmers to conduct farming activities in the social forestry area of Gerlang Village include areas, irrigation instruments, huts, agricultural equipment, seeds, fertilizers, and labor. Estimating carbon stocks from trees requires resources in the form of carbon stock measurement equipment based on the SNI 7724:2019 [39] on field measurements for area-based carbon accounting.

Key Activities

Key activities in social forestry area management are broadly divided into two types: agricultural area management and carbon storage value estimation based on the SNI 7724:2019 [39]. The key activities of agricultural area management include cultivation, planting, maintenance, harvesting, transportation, and sales. While the activity of estimating carbon storage value for trees consists of three stages, namely the measurement stage, the calculation stage, and standardization. The procedure used for the activity was based on the SNI 7724:2019. The verification and validation stages were conducted at an independent institution. This is important because carbon storage can only be converted into carbon credits if it meets standards. Therefore, they can be registered and traded on the carbon exchange market.

Key Partnership

Key partners are other parties that work with producers to achieve their objectives. This block describes the relationships with partners or supplier networks that create the business model. Ojek Tani is a partner of farmers in transporting fertilizer to the field and crops from the field to the house. The existence of Ojek Tani can increase the effectiveness of farmers' production activities, and vice versa, as members of the Ojek Tani community get new jobs in the social forestry area.

Several local government agencies collaborated with Gerlang Asri social forestry business group in social and environmental programs. Some have provided assistance in the form of plant seeds and the socialization of farmers' business development. Regional Public Water Company provided Arabica coffee plant seeds to Gerlang Asri social forestry business group as a program to increase regional coffee production. Food Security and Agriculture Office planted banyan trees for water conservation in the spring area. However, the programs ran only once on a small scale. Such cooperation has the potential to develop social forestry businesses if it can be conducted on a wider scale. Furthermore, to assess the carbon storage value of trees in the social forestry area, the Social Forestry Division of the Pekalongan Timur Forestry Management Unit is willing to provide training and assistance in carbon storage value assessment. Therefore, they can become potential partners for Gerlang Asri social forestry business group in climate change mitigation programs through agroforestry carbon sequestration.

Cost Structures

The cost structure includes all the costs incurred to run the business model. It describes the main costs that support the operation of a business model. It required for the business model in the social forestry area of

Gerlang Village includes investment and operational costs. The investment costs include the costs spent on the construction of huts, irrigation instruments, agricultural equipment, and biomass measurement equipment. The amount of investment costs reached IDR 75,687,000. Operational costs consist of area preparation costs, procurement of seeds, fertilizers, pesticides, watering, weeding, harvesting, and area of cultivation.

In the farming process, farmers use the services of farm laborers for area cultivation, weeding, and harvesting. The wage for farm laborers in Gerlang Village is IDR 60,000 per day. In addition to farm labor services, farmers use transport services to deliver fertilizer to the field and move the yields to the house. The cost of farm labor for transporting fertilizer is IDR 3,000–7,000, whereas the cost for transporting harvested crops is IDR 10,000–20,000. The details of the required operational costs are listed in Table 4.

Table 4. List of farmers' operational costs.

	Operational cost	Total (IDR per year)	Percentage (%)
A.	Preparation		
	Area cultivation services	6,180,456	12
	CM fertilizer	6,489,479	12
	Seedling procurement:		
	Potato	6,180,456	12
	Carrot	360,526	1
	Leek	2,060,152	4
	Chilli	30,902	0
	Arabica coffee	1,000,800	2
	Timber crops	993,600	2
B.	Planting and maintenance		
	NPK fertilizer	18,541,368	35
	Watering	3,893,687	7
	Weeding services	1,854,135	3
	Pesticide	3,064,476	6
C.	Harvesting		
	Harvesting services	1,236,090	2
	Fertilizer transportation	360,527	1
	Transportation of harvested products	1,445,853	3
	Total	53,692,507	100

The cost structure for estimating carbon stocks consists of measuring and calculating carbon stocks. Tree biomass was measured after the plants were five years old. Biomass measurement took approximately 10 working days with a total of 30 samples per 0.25 ha. The calculations in Table 5 use the estimated tool requirements for one worker in one plot of the area. A total of 10 samples representing field conditions were subjected to laboratory testing. This study used the Gajah Mada University's laboratory service fees to prepare the cost structure. After all the measurement processes were completed and the necessary data were complete, carbon value calculations were performed.

Table 5. List of costs for estimating the carbon storage value of trees on social forestry area in Gerlang Village.

Cost structure	Amount (IDR)	Percentage (%)
Biomass measurement equipment		
Clinometer	3,000,000	27
Meter	26,000	0
Ring soil sampler	1,000,000	9
Scientific scales	1,500,000	13
Cuttings scissors	50,000	0
Small saw	50,000	0
Plastic sample	61,000	1
Labor	700,000	6
Lab services	1,760,000	16
Calculation and report preparation	3,000,000	27
Total	11,147,000	100

Discussion

Based on the nine elements of the BMC framework, the business model developed had value propositions in the form of potatoes, carrots, leeks, chilies, arabica coffee, pine, and *S. wallicii* carbon stocks. The customer segments were housewives, restaurant owners, coffee shop owners, and CO_2-emitting companies. The products were distributed through collectors, wholesalers, local market vegetable traders, coffee bean traders, and voluntary carbon exchange markets. Farmers had direct links with networks of vegetable traders, coffee bean traders, and CO_2-emitting companies. Revenue streams were derived from fresh potato sales, carrot sales, leek sales, chili sales, coffee bean sales, and carbon credits. This new business model required key resources, such as land, irrigation instruments, farm equipment, seeds, fertilizer, laborers, and carbon storage measurement equipment. Key activities included land cultivation, planting, maintenance, harvesting, transporting, selling, and measuring and calculating carbon storage estimates. The partners in this business model were Ojek Tani, Regional Public Water Company, Food Security and Agriculture Office, and Pekalongan Timur Forest Management Unit. The cost structure consisted of investment costs, agricultural farming operations, and the cost of measuring and calculating the carbon storage estimates. A visualization of the new business model in the BMC framework is shown in Figure 5.

<table>
<tr><th>Key Partners</th><th>Key Activities</th><th>Value Proposition</th><th>Customer Relationships</th><th>Customer Segments</th></tr>
<tr><td rowspan="2">1.Ojek Tani
2.Regional Public Water Company (arabica coffee seedlings)
3.Food Security and Agriculture Office (spring area conservation)
4.Social Forestry Division of the Pekalongan Timur Forestry Management Unit</td><td>1.Land cultivation
2.Planting
3.Maintenance
4.Harvesting
5.Transport of fertilizer and crops
6.Sales
Carbon storage measurement and accounting</td><td rowspan="2">1.Fresh potatoes
2.Fresh carrots
3.Fresh leeks
4.Fresh Chillies
5.Arabica beans
6.CO_2e sequestration value (carbon credit)</td><td>1.Provide harvest information through social media (Whatsapp)
2.Provide lower prices to repeat customers
3.Provide updates on carbon storage values of timber stands</td><td rowspan="2">1. Consumers of fresh potatoes, carrots, onions, and chillies: Housewives and restaurant owners.
2. Consumers of coffee beans: coffee shops and coffee cafés around tourist areas in Batang
3. Carbon credit consumers: CO_2 emitting industries</td></tr>
<tr><td>Key Resources
1.Cultivation area
2.Irrigation instruments (reservoirs, diesel, pipeline)
3.Farming tools
4.Seedlings
5.Fertilizer
6.Labour
7.Hut
8.Carbon stock measurement equipment</td><td>Channels
1.Collecting traders
2.Vegetable traders in wholesale markets (Jakarta. Bogor. Sumatra. Kalimantan. Semarang. Yogyakarta)
3.Vegetable traders in the local market (Bandar. Batang. Limpung)
4.Coffee bean trader
5.Carbon exchange voluntary market</td></tr>
<tr><th colspan="3">Cost Structure</th><th colspan="2">Revenue Streams</th></tr>
<tr><td colspan="3">1.Land cultivation labour salary
2.Seedling
3.Fertilizer
4.Watering
5.Pesticide
6.Weeding labour salary
7.Harvesting labour salary
8.Fertiliser and crop transport services salary
9.Carbon stock measurement equipment
10. Carbon stock measurement labour salary
11. Carbon stock accounting labour salary</td><td colspan="2">1.Fresh potato sales
2.Fresh carrot sales
3.Fresh leek sales
4.Fresh chillies sales
5.Coffee bean sales (berries, green beans)
6.Carbon credit sales</td></tr>
</table>

Figure 5. A proposed BMC for forestry businesses at the social forestry area in Gerlang Village.

Based on the results obtained, it was found that area management in the social area of Gerlang Village was not optimal. Most farmers cultivated vegetable crops, especially potatoes, as their main commodity. Meanwhile, management in social forestry areas must pay attention to environmental aspects. Therefore, the value proposition of the new business model proposed several other commodities, such as arabica coffee beans and carbon storage from pine and *S. wallicii* trees. The cropping pattern was organized such that the optimum spacing of each commodity was considered. Researchers have also adopted the planting culture of local farmers, namely, conducting a crop rotation system, planting peripheral plants, and conducting their nurseries. These methods have long been used by farmers to reduce the costs of fertilizers, pesticides, and seeds. Buckley and Shortle's study in Buxton et al. [40] found that empirical knowledge increased farmers' awareness of the nutrient value of organic fertilisers, improving the efficiency of planning and resource use and ultimately reducing the use of chemical fertilisers. Adopting local knowledge is necessary to create a sustainable system [41]. Similarly, as stated by Buxton et al. [40], all stakeholders, including farmers, need to be recognized and engaged as equal partners in creating knowledge and innovation. Knowledge networks

and multi-actor knowledge networks facilitate knowledge exchange and shared learning and generate more integrated solutions [42].

The presence of pine and *S. wallicii* trees in the social forestry area of Gerlang Village was necessary for environmental sustainability. It was recommended that the trees not be cut down because they function in soil conservation in mountainous areas. Therefore, the potential value of carbon storage was raised for climate change mitigation projects, such as carbon sequestration. Several researchers researched the benefits derived from the carbon sequestration value of agroforestry. Farmers in East Africa participate in schemes that reward adopters of sustainable area management practices, including tree planting [43]. One example is the International Small Group Tree Planting (TIST) Program, which has been operating in Kenya, Tanzania, and Uganda since 2005 [44]. TIST calculates the carbon stored in participating members' farms, sells the carbon through the VCS Standard (Verra), and then pays farmers to plant trees. Since 2005, TIST has incentivized farmers to plant trees for a variety of goods, services, and carbon sequestration. From 2005 to 2010, TIST member farmers received an incentive from the sale of carbon credits of US$ 0.02 per tree [40]. The main challenges related to carbon sequestration revenues include high transaction costs for small projects, mismatches between community needs and project objectives, and slow and costly approval processes [45]. However, the advantage is that trees offer multiple benefits with carbon as an additional benefit. Thus, the area does not have to be taken out of its original use of carbon, and farmers' livelihoods are not compromised. Moreover, because the cost of carbon sequestration programs is high, agroforestry systems must be profitable; otherwise, farmers will not sacrifice more profitable cash crops for carbon sequestration [18].

Collaboration with local government agencies is needed to support the sustainability of farmers' businesses [46]. Cooperative relationships between farmers and external parties create new opportunities for knowledge exchange and innovation development [46,31]. Assistance in the form of Arabica coffee plant seeds can be a commodity that farmers can cultivate. Thus, farmers do not need to spend money to supply seeds. Other donations in the form of planting banyan trees in the spring area indirectly increase farmers' knowledge of the importance of preserving the water sources they use for their daily needs. Collaboration with the Ojek Tani community opens up new employment opportunities for local people. People who do not have cultivated areas can earn income by delivering fertilizer and yield. Since there has been a change in the area management system from Community-based Forest Management to Social Forestry, there has been no structural relationship between Blado Forest Management Unit Agency and the farmer groups. The existence of climate control projects or carbon sequestration by maintaining the presence of trees in the area opens up opportunities for new cooperative relationships between farmer groups and the Forest Management Unit.

One of the problems in selling these products is the lack of market access for farmers. Farmers are already busy with production activities in the field, making it impossible to sell goods directly to consumers. One way to deliver products to consumers is to understand the commodity supply chain [47]. By knowing the supply chain, farmers know where their yields can be channelled. In addition, by understanding the supply chain, farmers can adjust their crops to meet market needs. Farmers sort vegetables to enter wholesale or local markets. In the existing conditions, the supply chain of coffee bean commodities does not yet exist in Gerlang Village, and the supply chain of coffee beans is located in nearby villages. After the supply chain of coffee bean commodities is known, farmers can distribute the harvest of coffee beans in two ways: channelled through intermediary traders or directly to business actors. The study of the carbon trading market mechanism helped the researcher look for opportunities to channel the value of carbon storage through cooperation projects with carbon-emitting companies to enter the voluntary market mechanism [44].

After the value is delivered, there is value capture or receipt of benefits. The different harvest periods of each commodity cultivated in one plot of area are able to provide sustainable economic benefits [48]. Income from potato commodities can be obtained every three to four months, worsen in the sixth month, chillies every four months, and leeks every two to three months. Income from coffee bean commodities can be obtained after the crop is harvested in the fifth year. Meanwhile, the benefit value from the carbon sequestration project can be obtained when the trees reach a minimum age of five years. In addition to economic benefits, the presence of tree crops in the area provides ecological benefits such as soil conservation in mountainous areas [21,14]. Thus, this proposed business model was expected to help business sustainability in the social forestry area because its development had considered the existing business model conditions, ecological conditions, sociocultural conditions of the community, supply chain characteristics, and the latest market conditions [49,50].

Conclusions

A new business model was developed considering existing business conditions and was carried out by adding the beneficial value of arabica coffee and the carbon storage of pine and puspa trees to its value proposition. The customer segments were housewives, restaurant owners, coffee shop owners, and CO_2-emitting companies. The products were distributed through collectors, wholesale market vegetable traders, local market vegetable traders, coffee bean traders, and carbon market mechanisms. Farmers had direct relationships with a network of vegetable traders, coffee bean traders, coffee shop owners, and CO_2-emitting companies. Revenue streams were derived from the sale of harvested potatoes, carrots, leeks, chillies, arabica coffee beans, and carbon credit. This new business model required key resources such as land, irrigation instruments, farm equipment, seeds, fertilizers, laborers, and equipment to measure and calculate carbon storage estimates. The main activities included land cultivation, planting, maintenance, harvesting, transportation, selling, and measuring and calculating carbon stock estimates. The partners in this business model were the Ojek Tani community, Regional Public Water Company, Food Security and Agriculture Office, and Pekalongan Timur Forestry Management Unit. The cost structure consisted of investment costs, agricultural operational costs, and the costs of measuring and calculating carbon storage estimates.

Author Contributions

ARPS: Conceptualization, Methodology, Funding, Project Administration, Data Collecting, Software, Visualization, Writing - Original Draft, and Writing - Review & Editing; **HP**: Conceptualization, Supervision, and Validation; **ST**: Conceptualization and Supervision.

Conflicts of Interest

There are no conflicts to declare.

References

1. Bocken, N.M.P.; Short, S.W.; Rana, P.; Evans, S. A literature and practice review to develop sustainable business model archetypes. *J. Clean. Prod.* **2014**, *65*, 42–56, doi:10.1016/j.jclepro.2013.11.039.
2. D'Amato, D.; Veijonaho, S.; Toppinen, A. Towards sustainability? Forest-based circular bioeconomy business models in Finnish SMEs. *For. Policy Econ.* **2020**, *110*, 18–29, doi:10.1016/j.forpol.2018.12.004.
3. Hansen, E. Responding to the bioeconomy: Business model innovation in the forest sector. In *Environmental Impacts of Traditional and Innovative Forest-based Bioproducts*; Kutnar, A., Muthu, S.S., Eds.; Springer: Singapore, 2016; pp. 227–248, ISBN 978-981-10-0655-5.
4. Atewamba, C.; Boimah, M. Potential options for greening the Concessionary Forestry Business Model in rural Africa. *For. Policy Econ.* **2017**, *85*, 46–51, doi:10.1016/j.forpol.2017.08.015.
5. Kajanus, M.; Leban, V.; Glavonjić, P.; Krč, J.; Nedeljković, J.; Nonić, D.; Nybakk, E.; Posavec, S.; Riedl, M.; Teder, M.; et al. What can we learn from business models in the European forest sector: Exploring the key elements of new business model designs. *For. Policy Econ.* **2019**, *99*, 145–156, doi:10.1016/j.forpol.2018.04.005.
6. Salamzadeh, A.; Kesim, H.K.; Karami, M. Media business models: A holistic approach. In Proceedings of the 2nd International Conference of Research in Innovation and Technology, Tehran, Iran, 10–11 March 2019.
7. Schneider, S.; Spieth, P. Business model innovation: Towards an integrated future research agenda. *Int. J. Innov. Manag.* **2013**, *17*, 1–34, doi:10.1142/S136391961340001X.
8. Spieth, P.; Schneckenberg, D.; Ricart, J.E. Business model innovation - state of the art and future challenges for the field. *R D Manag.* **2014**, *44*, 237–247, doi:10.1111/radm.12071.
9. Fisher, G.; Wisneski, J.E.; Bakker, R.M. *Strategy in 3D: Essential Tools to Diagnose, Decide, and Deliver*; Oxford University Press: Oxford, England, UK, 2020; pp. 174–184, ISBN 978-019-00-8147-8.
10. Umar, A.; Sasongko, A.H.; Aguzman, G.; Sugiharto Business model canvas as a solution for competing strategy of small business in Indonesia. *Int. J. Entrep.* **2018**, *22*, 1–10.

11. Purnomo, H.; Puspitaloka, D. *Pembelajaran Pencegahan Kebakaran dan Restorasi Gambut Berbasis Masyarakat*; Purnomo, H., Puspitaloka, D., Eds.; Pusat Penelitian Kehutanan Internasional (CIFOR): Bogor, Indonesia, 2020; ISBN 978-602-38-7127-8.
12. Tjitradi, E.C. Evaluasi dan perancangan model bisnis berdasarkan *Business Model Canvas*. *AGORA* **2015**, *3*, 8–16.
13. Pek, R.; Riedl, M.; Jarskí, V. Innovative approaches in forest management - the application of a business model to designing a small-scale forestry strategy. *J. For. Sci.* **2017**, *63*, 393–400, doi:10.17221/17/2017-JFS.
14. Ramadhanti, S.; Wasis, B.; Hilwan, I. Pendugaan simpanan karbon pada bagian atas dan bawah permukaan tanah di Taman Hutan Raya Banten. *J. Penelit. Hutan Tanam.* **2023**, *20*, 19–36, doi:10.59465/jpht.v20i1.160.
15. Firyadi, F.; Widiatmaka, W.; Iswati, A.; Muhamad, A.; Mulyanto, B. Neraca karbon, emisi dan serapan historis CO_2 karena perubahan penggunaan lahan di Kabupaten Banyuasin, Sumatera Selatan. *Journal Nat. Resour. Environ. Manag.* **2018**, *8*, 178–187, doi:10.29244/jpsl.8.2.178-187.
16. Sunarno; Rahadian, R.; Suedy, S.W.A.; Pradika, B.; Adistya, B.; Wahyudi, F.; Rahman, A.Z.; Paramasatya, S.; Widiartanto. Potensi dan nilai ekonomi cadangan karbon pada area hijau yang dikelola oleh PT. Pertamina (Persero) Fuel Terminal Boyolali. *Media Bina Ilm.* **2020**, *15*, 4201–4216.
17. Jaya, R.; Yusriana; Fitria, E. Review manajemen rantai pasok produk pertanian berkelanjutan: Konseptual, isu terkini, dan penelitian mendatang. *J. Ilmu Pertan. Indones.* **2020**, *26*, 78–91, doi:10.18343/jipi.26.1.78.
18. Muthuri, C.W.; Kuyah, S.; Njenga, M.; Kuria, A.; Öborn, I.; van Noordwijk, M. Agroforestry's contribution to livelihoods and carbon sequestration in East Africa: A systematic review. *Trees, For. People* **2023**, *14*, 1–20, doi:10.1016/j.tfp.2023.100432.
19. Telwala, Y. Unlocking the potential of agroforestry as a nature-based solution for localizing sustainable development goals: A case study from a drought-prone region in rural India. *Nature-Based Solut.* **2023**, *3*, 1–9, doi:10.1016/j.nbsj.2022.100045.
20. Willmott, A.; Willmott, M.; Grass, I.; Lusiana, B.; Cotter, M. Harnessing the socio-ecological benefits of agroforestry diversification in social forestry with functional and phylogenetic tools. *Environ. Dev.* **2023**, *47*, 1–15, doi: 10.1016/j.envdev.2023.100881.
21. Nurchayati, Y.; Setiari, N.; Dewi, N.K.; Meinaswati, F.S. Karakterisasi morfologi dan fisiologi dari tigavarietas kentang (*Solanum tuberosum* L.) di Kabupaten Magelang Jawa Tengah. *NICHE J. Trop. Biol.* **2019**, *2*, 38–45.
22. Oktafiyanto, M.F.; Ibrahim, R. Keragaman dan kelimpahan Nematoda secara horizontal dan vertikal pada beberapa tanaman sayur di Kabupaten Cianjur. *Agro Wiralodra* **2021**, *4*, 9–15, doi:10.31943/agrowiralodra.v4i1.57.
23. Marpaung, P.H.P.; Siburian, F.; Nainggolan, L.P. Analisis yang mempengaruhi rotasi tanaman ercis (*Pisum sativum* L) ke tanaman wortel (*Daucus carota* L) Kecamatan Dolat Raya, Kabupaten Karo. *J. Agroteknosains* **2022**, *6*, 80–87, doi:10.36764/ja.v6i1.757.
24. Baudry, X.; Doury, G.; Couty, A.; Fourdrain, Y.; van Havermaet, R.; Lateur, M.; Ameline, A. Antagonist effects of the leek *Allium porrum* as a companion plant on aphid host plant colonization. *Sci. Rep.* **2021**, *11*, 1–9, doi:10.1038/s41598-021-83580-8.
25. Lengai, G.M.W.; Muthomi, J.W.; Mbega, E.R. Phytochemical activity and role of botanical pesticides in pest management for sustainable agricultural crop production. *Sci. African* **2020**, *7*, 1–13, doi:10.1016/j.sciaf.2019.e00239.
26. Nurmas, A.; Mallarangeng, R.; Adawiyah, R. Jenis, populasi dan intensitas serangan hama pada tumpangsari kubis dan bawang daun serta produktivitas lahan. *J. Agron. Res.* **2023**, *11*, 57–66.
27. Siarudin, M.; Rahman, S.A.; Artati, Y.; Indrajaya, Y.; Narulita, S.; Ardha, M.J.; Larjavaara, M. Carbon sequestration potential of agroforestry systems in degraded landscapes in west Java, Indonesia. *Forests* **2021**, *12*, 1–13, d oi:10.3390/f12060714.

28. Nugraheni, S.S.; Tinaprilla, N.; Rachmina, D. Pengaruh penggunaan benih bersertifikat terhadap produksi dan efisiensi teknis usahatani kentang di Kecamatan Pangalengan. *J. Agribisnis Indones.* **2022**, *10*, 389–401, doi:10.29244/jai.2022.10.2.389-401.

29. Streck, C. How voluntary canrbon markets can drive climate ambition. *J. Energy Nat. Resour. Law* **2021**, *39*, 367–374, doi:10.1080/02646811.2021.1881275.

30. Guo, W.; Shi, Y.; Liu, Y.; Su, M. CO_2 emissions retrieval from coal-fired power plants based on OCO-2/3 satellite observations and a Gaussian plume model. *J. Clean. Prod.* **2023**, *397*, doi:10.1016/J.JCLEPRO.2023.136525.

31. Jannah, M.; Suteki; Budiyanto. Pengaruh implementasi corporate social responsibility PT Bhimasena Power Indonesia terhadap kesejahteraan hidup masyarakat Desa Karanggeneng Kabupaten Batang (Studi kasus PT. Bhimasena Power Indonesia, Batang). *Diponegoro Law J.* **2021**, *10*, 167–178.

32. Adawiyah, F.M.N.; Murdianto. Analisis keberhasilan program corporate social responsibility PT. Bhimasena Power Indonesia dengan tingkat kesejahteraan masyarakat. *J. Sains Komun. dan Pengemb. Masy.* **2022**, *6*, 331–345, doi:10.29244/jskpm.v6i3.940.

33. Grass, I.; Kubitza, C.; Krishna, V. V.; Corre, M.D.; Mußhoff, O.; Pütz, P.; Drescher, J.; Rembold, K.; Ariyanti, E.S.; Barnes, A.D.; et al. Trade-offs between multifunctionality and profit in tropical smallholder landscapes. *Nat. Commun.* **2020**, *11*, 1–13, doi:10.1038/s41467-020-15013-5.

34. Clough, Y.; Krishna, V. V.; Corre, M.D.; Darras, K.; Denmead, L.H.; Meijide, A.; Moser, S.; Musshoff, O.; Steinebach, S.; Veldkamp, E.; et al. Land-use choices follow profitability at the expense of ecological functions in Indonesian smallholder landscapes. *Nat. Commun.* **2016**, *7*, 1–12, doi:10.1038/ncomms13137.

35. Makkarennu; Mahbub, A.S.; Ridwan. An integration of business model canvas on prioritizing strategy: Case study of small scale nontimber forest product (NTFP) enterprises in Indonesia. *Small-scale For.* **2021**, *20*, 161–174, doi:10.1007/s11842-020-09462-5.

36. Liu, G.; Liu, Q.; Song, M.; Chen, J.; Zhang, C.; Meng, X.; Zhao, J.; Lu, H. Costs and carbon sequestration assessment for REDD+ in Indonesia. *Forests* **2020**, *11*, 1–16, doi:10.3390/F11070770.

37. Suseno, D.P.Y. Dukungan standardisasi dalam perdagangan karbon hutan. *Standar: Better Standard Better Living* **2023**, *2*, 13–17.

38. Hidayah, F.N.; Subagiyo; Santoso, A. Nilai simpanan dan harga karbon ekosistem mangrove Desa Pasar Banggi, Rembang, Jawa Tengah. *J. Mar. Res.* **2023**, *12*, 187–195.

39. Badan Standardisasi Nasional. Pengukuran dan Perhitungan Cadangan Karbon - Pengukuran Lapangan untuk Penaksiran Cadangan Karbon Berbasis Lahan. SNI 7724:2019; Badan Standardisasi Nasional: Jakarta, Indonesia, 2019.

40. Buxton, J.; Powell, T.; Ambler, J.; Boulton, C.; Nicholson, A.; Arthur, R.; Lees, K.; Williams, H.; Lenton, T.M. Community-driven tree planting greens the neighbouring landscape. *Sci. Rep.* **2021**, *11*, 1–9, doi:10.1038/s41598-021-96973-6.

41. Andrews-Key, S.A.; Leblanc, P.A.; Nelson, H.W. A business case for climate change adaptation by forest industry in central Canada. *For. Chron.* **2021**, *97*, 148–157, doi:10.5558/tfc2021-016.

42. Lee, J.Y.; Chang, C.H. Efforts toward creating a sustainable business model: An empirical investigation of small-scale certified forestry firms in Taiwan. *Sustain.* **2019**, *11*, 1–20, doi:10.3390/su11092523.

43. Foster, K.; Neufeldt, H. Biocarbon projects in agroforestry: Lessons from the past for future development. *Curr. Opin. Environ. Sustain.* **2014**, *6*, 148–154, doi:10.1016/j.cosust.2013.12.002.

44. Benjamin, E.O.; Sauer, J. The cost effectiveness of payments for ecosystem services—Smallholders and agroforestry in Africa. *Land Use Policy* **2018**, *71*, 293–302, doi:10.1016/j.landusepol.2017.12.001.

45. Kreibich, N.; Hermwille, L. Caught in between: Credibility and feasibility of the voluntary carbon market post-2020. *Clim. Policy* **2021**, *21*, 939–957, doi:10.1080/14693062.2021.1948384.

46. Geissdoerfer, M.; Vladimirova, D.; Evans, S. Sustainable business model innovation: A review. *J. Clean. Prod.* **2018**, *198*, 401–416, doi:10.1016/j.jclepro.2018.06.240.

47. Šūmane, S.; Kunda, I.; Knickel, K.; Strauss, A.; Tisenkopfs, T.; Rios, I.I.; Rivera, M.; Chebach, T.; Ashkenazy, A. Local and farmers' knowledge matters! How integrating informal and formal knowledge enhances

sustainable and resilient agriculture. *J. Rural Stud.* **2018**, *59*, 232–241, doi:10.1016/j.jrurstud.2017.01.020.

48. Wezel, A.; Herren, B.G.; Kerr, R.B.; Barrios, E.; Gonçalves, A.L.R.; Sinclair, F. Agroecological principles and elements and their implications for transitioning to sustainable food systems. A review. *Agron. Sustain. Dev.* **2020**, *40*, 1–13, doi:10.1007/s13593-020-00646-z.
49. Leakey, R.R.B. A re-boot of tropical agriculture benefits food production, rural economies, health, social justice and the environment. *Nat. Food* **2020**, *1*, 260–265, doi:10.1038/s43016-020-0076-z.
50. Nyberg, Y.; Musee, C.; Wachiye, E.; Jonsson, M.; Wetterlind, J.; Öborn, I. Effects of agroforestry and other sustainable practices in the Kenya Agricultural Carbon Project (KACP). *Land* **2020**, *9*, 1–22, doi:10.3390/land9100389.