

# Greenhouse Potential based on Ecotourism and Education for Sustainable Village Economic Resilience

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**Abstract**—Indonesia has many rural areas with diversity and uniqueness in each region that have developed into eco-tourism. The village that is being developed as an eco-tourism destination is expected to improve the welfare of the surrounding community. Developed eco-tourism can provide jobs for residents in the village. Eco-tourism is also one of the developments to preserve ecosystems in rural areas. This eco-tourism sector can support community welfare and sustainable rural development. One approach to the development of rural areas is through village ecotourism. Village Ecotourism is a rural area with several special characteristics that can be used as a tourist destination. One way to improve the development of village ecotourism is by adding new facilities that lead to educational tourism, i.e., greenhouse facilities. The existence of this greenhouse can be used as a means of science education about a more advanced agricultural system with a controlled environmental system. Greenhouse technology can improve the quality and quantity of plant productivity, thereby increasing people's income, and producing healthier organic plant products. Greenhouses can also be used as educational tourism facilities for various science education activities and simple agricultural training. Training for residents can also be carried out, for community empowerment, such as training in planting, fertilizing, nurseries, processing plant products, and the process of packaging plant products. This review summarizes the various potentials of Greenhouse development for the development of education-based village ecotourism and provides references for further research that focuses on community service, which is increasing sustainable village economic resilience.

**Keywords**—Ecotourism, Educational Tourism, Greenhouse.

## I. INTRODUCTION

INDONESIA is one of the countries in the world that prioritizes tourism as a source of foreign exchange because it has various regions as tourist destinations. The diversity of tourism in each region in Indonesia is different and has its uniqueness. The tourism sector in Indonesia can support community welfare and community empowerment, especially the development of sustainable rural areas. Sustainable tourism development in rural areas is expected to be a model of sustainable development by government policies in the field of tourism [1]. The ongoing social and economic decline that has occurred has also had a large impact on rural communities. This can lead to rural areas becoming uninhabited and cultural heritage being lost. So we



Figure 1. Mixed-type greenhouse (single-span and multispan).

Table 1.  
Distribution of Greenhouses Sizes

Greenhouse Size (m <sup>2</sup> )	Frequency	% of Total Greenhouse	% Total Capacity	% Total Active Capacity
Up to 279	138	50	16	7
280 – 557	60	22	14	7
558 – 836	24	9	10	8
837 – 1114	16	6	7	14
1115 - 1393	10	4	5	14
Over 1393	27	10	48	50

need an alternative as a driver of sustainable development in rural areas [2].

One approach to the development of rural areas is through village eco-tourism. Each village has the potential to become a village eco-tourism because it is supported by its unique nature and traditions. A village eco-tourism is a rural area that has several special characteristics that can be used as a tourist destination. A village eco-tourism must have several supporting factors, such as agricultural systems, natural, and environmental conditions that are still pristine and preserved [3]. One way to improve the development of a village eco-tourism is by adding new facilities that lead to educational tourism, namely greenhouse facilities. The existence of this greenhouse can be used as a means of science education about a more advanced agricultural system with a controlled environmental system [4].

The greenhouse is a system for modifying the management of environmental factors that allows plants to grow in a suitable climate. Greenhouse technology is also one of the

technologies that can be used to increase crop productivity by controlling the local environment. Increasing crop yields can be done by increasing crop production in terms of quantity and quality, which can be done by controlling field conditions. Greenhouse structures are covered with glass or plastic film with a transparent and translucent material. Thus, this technology is very important, especially in rural areas with extreme climatic conditions or areas with high rainfall [5].

The potential of the greenhouse in village eco-tourism is quite lot, ranging from science education tourism destinations, increasing yield and quality of plant production, producing healthier organic plant products, empowering better quality surrounding communities, and others. This paper aims to summarize the various potentials of greenhouses for the development of education-based village eco-tourism and provide references for further research that focuses on community service, specifically increasing sustainable village economic resilience.

## II. RESULT AND DISCUSSION

### A. The Greenhouse Potential for Science Educational Tourism

Educational tourism has a specific purpose, such as a certain interest and attraction to a particular topic on which there is learning (formal or experimental). Educational tourism has several benefits, it is more experienced people who can interact directly with those who do educational tours, learning is not boring because it can be obtained in a fun way, and tourists are also more involved in the learning process, so they have sharper observation skills and can save memory better [6].

Educational tourism in rural areas is often associated with agrotourism or activities that internalize the multifunctionality of agriculture into tourist areas. This multifunction includes the maintenance of biodiversity, rural heritage, and agricultural education functions, as well as the rural environment. Ecotourism that has an educational tourism component can allow visitors to have the opportunity to be more aware of and learn about agriculture, local products, traditional foods, and the daily lives of rural communities. The role of this educational tour can also be done by showing children (as tourists) various products from the greenhouse and some of the agricultural techniques used in the greenhouse. Furthermore, it can provide direct training on how to plant plants in the greenhouse, which can be followed by tourists [7].

The type of greenhouse can be distinguished based on the shape of the building design. This greenhouse design affects the strength of the structure and environmental conditions in the greenhouse. The greenhouse design for each area is different, according to the environmental conditions. Greenhouse designs for tropical areas, such as in Indonesia, are characterized by greenhouses that have ventilation openings. This is because the air temperature is too high in the tropics, so there is a lot of infrared radiation. Meanwhile, in sub-tropical areas and countries that have four seasons, the greenhouse design is more closed. This is because, during winter, the air in the greenhouse is maintained so that it does

Table 2.  
Plant Growth and Yield Characteristics of Tomato Plants under Poly-Greenhouse and Open Field Conditions

Plant Growth and Yield Characteristics	First Season		Second Season	
	Poly-greenhouse	Open Field	Poly-greenhouse	Open Field
Plant height (cm)	106,0	75,0	84,0	69,0
Node number	27,4	24,3	19,7	18,9
Internodal length (cm)	3,8	3,0	4,2	3,6
Average fruit weight (g)	86,5	65,1	90,0	84,4
Yield per plant (g)	2145,2	981,0	2156,2	1382,3
Dry matter production (g)	74,6	34,1	171,1	89,0

not come out. Greenhouse design greatly affects plant growth because the greenhouse environment greatly affects the state of the plants in it [8].

Greenhouse designs that are suitable for the climate in Indonesia are mixed-type greenhouses (Single span and Multispan), which can be seen in Figure 1. This mixed type is a mixture of the tunnel type. This mixed type is a hybrid type between the tunnel type and the piggy-back type. Mixed-type greenhouses have the advantage of having a stronger structure and also having a maximum open ventilation type. Another advantage of this type is that several greenhouse units (single span) can be combined into one large block greenhouse (Multispan), which cannot be done in a tunnel-type greenhouse. Multispan greenhouses for manufacturing costs are also relatively more efficient, so for the manufacture of large types of 15,886 square meters. The most common greenhouse size greenhouses, this type is very suitable [8]. The size of the greenhouse design varies greatly, ranging from 18.5 square meters to design is 279 square meters (Table 1). The design size of this 279 square-meter greenhouse is the size of a greenhouse with an active cultivation capacity [9].

### B. The Greenhouse Potential in Crop Production

The greenhouse cultivation system is the most intensive form of plant production with yields per unit area of cultivation up to 10 times superior to crop production in field conditions. Various types of plants, ranging from vegetables and ornamental plants to fruit plants, have been cultivated in greenhouse systems throughout the world. This greenhouse cultivation system provides a controlled microclimate that can be adapted to the conditions of plant needs so that it can produce higher quality yields and can extend the availability of market products [10]. The results obtained from the cultivation of tomato plants from the research conducted by Tiwari and Chaudhury (1986) showed that the production of tomato plants from cultivation in greenhouses resulted in a plant yield 2 times greater than the cultivation in open fields. The results of the measurement of plant growth characters (Table 2), showed that plant height, a number of segments, length of segments, average fruit weight, yield per plant, and plant dry weight production was higher in greenhouse cultivation than in open field cultivation. In greenhouse cultivation, yields per plant showed high yields of 2145 g/plant and 2156 g/plant in the first and second seasons compared to open-field cultivation. The fruit size of the plants in the greenhouse was larger, at 86.51 g and 90.05 g in the first and second seasons [11].

The implementation of the greenhouse cultivation system must still apply the principle of sustainability, which still pays attention to resource conservation and social support that is commercially competitive and environmentally friendly. This greenhouse system relies on several things, such as cultivation techniques, equipment management, and construction materials that aim to reduce the use of agricultural chemicals, excessive energy and water consumption and waste piles. The goal of sustainable greenhouses can be achieved in various ways, such as efficient management of climate parameters (solar radiation, air temperature, relative humidity, and carbon dioxide (CO<sub>2</sub>) concentration) to ensure suitable plant growth conditions and energy savings, use of renewable energy sources as a substitute for fossil fuels, the use of innovative greenhouse covering materials with appropriate physical properties by taking into account the potential for waste generation from the greenhouse cover after use, optimizing the provision of water and nutrients to plants to reduce water drainage consumption by conserving groundwater, and pest management, also reducing agricultural chemicals significantly [10].

Conventional greenhouse structures applied in Indonesia (tropical regions) require constant climate control, so they are expensive and unsustainable. So we need appropriate environmental climate control to create optimal growth conditions for plants. Analysis of heat and airflow is needed as an alternative to controlling the environmental climate and reducing excessive water use [12]. Sustainable crop production is an effort to control the microclimate while taking into account the level of consumption of renewable resources. This means that the emission level of the pollutant must not exceed the capacity of the environment to absorb it. Efforts to control this microclimate focus on parameters that affect the microclimate of plants such as temperature, humidity, and carbon dioxide concentration in the greenhouse [10].

### C. The Greenhouse Potential in Community Empowerment

Ecotourism and educational tourism have become well-known in various parts of the world for empowering local communities, both socially and economically [7]. The development of village eco-tourism and educational tourism can help improve the economy of the surrounding community. The community's economy can be improved through various activities such as socializing the development of tourist villages (socialization regarding the construction and development of greenhouse facilities) and training on making greenhouses and planting procedures in greenhouses. We can see those process in both Figure 2 and Figure 3. This can support the surrounding community to learn a lot and get directly involved in these activities [13].

Socialization activities can be applied to the village's ecotourism and educational tourism, one of which is socialization regarding the use of greenhouses. The socialization can be carried out for 3 to 5 days with various themes. Socialization can start with the definition of a greenhouse, plant production processes such as how to sow plants, how to choose good plant seeds, how to plant in a greenhouse, how to care for plants in a greenhouse, fertilizing, and weeding plants [14]. In addition to socialization, a training process can be carried out, starting from training on making greenhouses and



Figure 2. (a) Crop production socialization for school children; (b) Crop production socialization for resident.



Figure 3. (a) Greenhouse frame assembly; (b) Manufacture of greenhouse components; (c) Greenhouse cover installation.

planting plants in greenhouses directly, so that visitors and residents can directly participate in this activity [15].

### D. The Greenhouse Potential in Ecotourism Development

Ecotourism and educational tourism located in villages can contribute to additional income, cash flow, and agricultural profitability by providing alternative income through agricultural products from greenhouses. Products from the greenhouse in the form of fruit, vegetables, and flower plants can be commercialized on the tour as souvenirs for tourists [7]. Greenhouse products can also be distributed to various sellers around the tourist village or can be processed into other products and commercialized. Plant products from greenhouses are products that do not use chemical fertilizers and chemical pesticides in the cultivation process, so greenhouse products, especially fruits and vegetables, can be labeled with a special "organic" label. The results of organic fruit and vegetable products are now more in demand by many people because they are healthier and better for health [16].

Greenhouse products before being commercialized must be packaged in such a way with good packaging to increase consumer interest in the product (Figure 4 and Figure 5). In addition, the packaging is also useful as a product protector from damage during distribution and physical disturbances from the outside, and, to facilitate the distribution process. The packaging used is also required to be made of environmentally friendly materials so that it does not cause a pile of garbage in the environment. Containers used to transport goods are made from durable materials that are not easily damaged so that they can be used repeatedly (reuse system application) [16].



Figure 4. (a) Large container; (b) Small container; (c) Medium container.



Figure 5. (a) Greenhouse frame assembly; (b) Manufacture of greenhouse components; (c) Greenhouse cover installation.

### III. CONCLUSION

Greenhouses have various potentials for being applied to village eco-tourism and educational tourism. One of the potential greenhouses for science education tourism that can be applied is as a means of direct experimental learning. Single-span and multi-span greenhouses are appropriate for use in Indonesia. Greenhouse cultivation systems can increase crop productivity compared to crops grown under open field conditions. Community empowerment through greenhouses in ecotourism villages can be done through socialization and plant production training at the greenhouse. Greenhouse products can be commercialized as tourist souvenirs so that they can develop ecotourism areas.

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