Role of Appropriate Technology on Agricultural Development in Asia

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ABSTRACT

The increase in the world's population has increased the demand for food needs. Increasing agricultural and processed products is very important to offset the rise in food demand. Appropriate technology application in the agricultural sector has become essential to ensure a significant increase in agricultural products. As found in Asia regions, appropriate technology was applied to crop production, postharvest handling, and raw agricultural product processing. Low-cost technology was suitable for agricultural development in the Asian region, particularly in developing countries. The use of appropriate technology has increased food production and minimized environmental damage. Hence sustainable agriculture can be realized. This study highlights the role of appropriate technology for food production and processing in the Asian region by using bibliometric analysis. Some case studies from the authors and other sources were reviewed. The study results showed that applying appropriate technology in the agricultural sector has been proven to improve agricultural development, especially in agricultural production and the processing of raw agricultural products. Using the right technology increases the efficiency of the product price and improves the quality of processed products. The type of technology used was determined based on the local community's needs. Appropriate technology must be affordable and easy to design using local materials. The involvement of various parties, such as the government, the private sector, and universities, in providing funding, technology, and assistance is essential in successfully applying appropriate technology.

Keywords: Agricultural Development, Appropriate Technology, Low-Cost Technology, Sustainable Agriculture.

1 Introduction

Agriculture provides food for the community, especially in urban areas. The increase in world population, especially in developing countries, needs to be balanced with increased agricultural production. Although agriculture is vital, production costs are sometimes greater than crop income. The use of technology, including machinery in the agricultural sector, without taking into account the economic aspect, in the end, will increase production costs without increasing income. Agricultural practices must provide economic benefits for farmers so that the sustainability of agricultural practices can be maintained. Farmer welfare is one of the keys to agricultural sustainability. Appropriate technology (AT) allows agricultural practices with low production costs based on local potential [1]. The right technology, in principle, uses various methods to meet the needs of life according to needs by optimizing the use of local resources [2]. It offers solutions to increase agricultural production at an affordable cost. The forms of technology produced are various according to the needs and availability of funds. Appropriate technology is also essential in developing agriculture-based industries [3].

Appropriate technology has developed very quickly in various fields, including agriculture. It has been widely used, especially in developing countries where expensive technology is hard to apply [2]. Besides being low-cost and using local resources, appropriate technologies usually use low-energy inputs and are environmentally friendly. Many appropriate technologies are made by modifying advanced and expensive technologies to be more straightforward according to local needs. The socio-economic conditions of the community are also an essential factor in developing appropriate technology [4]. In agriculture, appropriate

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technology is usually used to solve various problems ranging from crop production, postharvest handling, and the processing of raw agricultural products [5, 6]. Appropriate technology developments in agriculture worldwide are occasionally increasing, including in Asia. In this study, several examples of the application of technology are reviewed in terms of technology development and its implementation related to the socio-economic aspects of society. Finally, several strategies that have succeeded in realizing the sustainable use of appropriate technology can be used as a reference in developing further technology in the future.

2 Methodology

This study conducted an output-based assessment of several appropriate technology applications in the Asian region. Three main indicators are used for the assessment: the level of community participation, the successful application of technology, and the socio-economic impact. The level of community participation is considered successful if at least 75% of the beneficiary community members are actively involved in developing and applying appropriate technology. Beneficiaries were community groups in some administrative regions. Implementing technology is successful if the required and planned technology is successfully made and adequately functions. Meanwhile, the last indicator (socio-economic aspect) is successful if appropriate technology can increase people's income and strengthen community institutions such as cooperatives, small and medium enterprises, farmer groups, and other institutions. This study also performed bibliometric analysis to highlight the other related studies in Asian regions. Hence, several examples of case studies discussed can provide accurate references.

3 Results and Discussion

In line with the aims of the sustainable development goal (SDGs), where the main focus is solving various environmental and socio-economic problems, the existence of appropriate technology is a factor strengthening the achievement of the SDGs targets, especially in developing countries. Therefore, the development of appropriate technology needs special attention from the government. Some good practice examples are discussed in this study.

3.1 Agricultural Crop Production Technology

Agricultural crop cultivation is a key factor in the food supply. Although current crop cultivation technology is relatively easy to learn from various sources, in practice, there are many inhibiting factors, such as the limited availability of water. Drought has reportedly caused many plant deaths resulting in crop failures. Therefore, one of the appropriate technologies used to overcome the problem of drought is jug irrigation, as applied in Indonesia (Figure 1).

Figure 1*: Jug for Irrigation in Indonesia (Source: Setyawan et al., 2020 [6])*.

A jug is a container made of clay that is usually used to store food. Jugs that have not reached the finishing stage still have pores that allow water to pass through. This kind of jug was used for irrigation in dryland areas. The volume of the jug varies. For small plants and vegetables, usually use a jug with a 1-liter capacity. The water in the jug seeps out, wetting the soil around the plant roots, and will run out after about four

days. This technology saves water and energy for irrigation in dry seasons and prevents crops from dying [6]. Active community participation is essential in ensuring this technology's continued use.

Meanwhile, in Pakistan, low agricultural production due to environmental degradation was overcome by implementing farm forestry, where the cultivation of food crops was carried out simultaneously with the cultivation of timber plants. Agricultural and timber crop yields increased farmers' income [7]. Another example of the application of appropriate technology in the field of agricultural production in Pakistan is the application of land conservation technology to increase food crop production. Some technologies include making bench terraces, mounds, and ground cover crops [8]. These technologies aim to control runoff and soil erosion to maintain soil fertility and increase rainwater infiltration into the soil. Land conservation, soil fertility, and soil moisture availability can be maintained, increasing food crop production. Figure 2 shows an example of a mounds terrace to optimize rainwater harvesting in Pakistan.

Figure 2: *Mounds Terrace Practices in Farmland of Pakistan (Source: Ali et al., 2018 [8])*

Another example of the application of technology is the development of greenhouses with heat dissipation technology in Taiwan (Figure 3). Heat dissipation technology can be applied to small or large-scale greenhouses for cultivating vegetables and other food crops. Greenhouses use affordable ventilation fans to naturally regulate heat in the building so that the temperature can be regulated according to the conditions for growing plants. The use of this technology increases the production of food crops, especially in urban areas and also in areas that have erratic climatic conditions.

Figure 3: *Green House with Heat Control System in Taiwan (Source: Author's Documentation)*

Although most of the appropriate technology is needed in developing countries, the development of appropriate technology in developed countries is also massive. Hereafter, many appropriate technologies developed by developed countries are applied in developing countries [2].

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3.2 Postharvest Technology

Postharvest handling plays a vital role in maintaining the quality of food that has been harvested and the smoothness of the food supply chain. It maintains the quality of the harvest until it reaches the final consumer. Using appropriate postharvest technology significantly increases food production quality and quantity, as happened in Thailand [9]. The use of appropriate technology in this country is very high and is an essential factor in boosting exports of agricultural products. Appropriate technology is not only used in small-scale agricultural practices but is also used in the industrial sector. Figure 4 shows an example of appropriate technology applications for the industry in Thailand.

Figure 4: *Development of Pneumatic Harvesting Tool for Palm Oil Industry (left) and Inter-Row Cultivator for Rice Plantation Industry in Thailand (right) (Source: Khaehanchanpong, 2018 [10])*

Appropriate technology for postharvest was also found in other Asian countries such as India and Iran. As found in other developing countries, these countries rely on agriculture as one of the main strengths of their economy. Several appropriate technologies have been produced to increase strategic agricultural commodities' production for domestic and export needs. Figure 5 shows examples of appropriate technology development for groundnut harvesting in India and cotton planting in Iran. Groundnut digger was developed according to the related problems found. The results showed that diggers could increase the efficiency of peanut harvesting so that costs and energy for harvesting could be reduced significantly [11]. Whereas the planter developed in Iran increases the efficiency of cotton planting and reduces cost and energy requirements [12].

Figure 5: *Groundnut Digger in India (left) and Cotton Planter in Iran (right) (Source: Anil et al., 2020 and Roozbeh and Jowkar, 2020 [11], [12]).*

3.3 Raw Agricultural Product Processing Technology

Appropriate technology was also applied in food processing besides crop production and postharvest. Appropriate technology increases the added value of agricultural raw products into ready-to-consume food products. Some of the technologies used can gain processed products with good standards. This significantly increases the selling value and the income of the community (small and medium industries). One example of technology for food processing is the technology developed in Indonesia for producing brown sugar from coconut plants. Applying the Good Manufacturing Practice (GMP) concept with constructing a standardized production kitchen can increase the quality and quantity of brown sugar production in small and medium industries (Figure 6).

Figure 6: *GMP-based Brown Sugar Production House in Indonesia (Source: Author's Documentation).*

Another example of appropriate technology for food processing is eco-friendly stoves developed in China [13] and the green technology concept for coffee processing in Malaysia [14]. Using eco-friendly stoves reduces energy input and harmful gas emissions produced during cooking. At the same time, green technology for coffee processing offers a zero-waste concept on coffee processing mill effluent. In addition, developing appropriate technologies creates environmentally friendly food processing tools and methods. This technology increases the efficiency of processing food products by reducing energy use and costs and minimizing the negative impact on the environment.

3.4 Discussions

The contribution of appropriate technology to agricultural development in the Asian region is well highlighted. Appropriate technology provides solutions to problems in agricultural crop production, postharvest handling, and the processing of raw agricultural products from household-scale farming to large-scale industrial agriculture. Appropriate technology offers low-cost production methods at the level of household farms and small and medium enterprises [6, 10]. The introduced technology is relatively easy to practice but requires field assistance until the community understands it well. Using local resources facilitates the remanufacturing and repairing spare parts from the appropriate technology developed. These local resources are closely related to the people's environmental and socio-economic conditions, so the technology produced varies [2]. In large-scale agro-industry, appropriate technology contributes to increasing the production scale. Appropriate technology has even become an essential key in the supply of agricultural commodities for export, as found in Thailand [9]. However, a massive development of proper technology is still needed to solve various unresolved problems in agriculture.

4 Conclusions

Developing research in the field of appropriate technology by involving various research institutions creates technologies according to local needs and resources. Research funding assistance from various sources for appropriate technology research based on local needs and resources accelerates the discovery of new

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technologies to solve various problems in the agricultural sector. Appropriate technology solves various problems in society and small and medium enterprises and can also solve multiple problems in the large-scale agricultural industry. Assisting the use of appropriate technology from research institutions of higher education, government, and private party increase the effective transfer of knowledge to the community.

5 Declarations

5.1 Study Limitations

This online study highlighted applications in some countries in the north, south, east, west, and central of Asia to reflect the development of appropriate technology in agriculture.

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