Check for updates

GPH-JOURNAL OF AGRICULTURE & RESEARCH

GPH-INTERNATIONAL JOURNAL OF AGRICULTURE & RESEARCH
www.gphjournal.org

INTEGRATED MECHANIZATION MODEL:
Strategy to Increase Production and Welfare of Farmers In East Kalimantan, Anticipating Population Growth In Ibu Kota Nusantara (IKN)

Aswin

Lecturer of Agribusiness Study Program, Faculty of Agriculture,
Mulawarman University, Samarinda.
Email: *bungaswin@unmul.ac.id*

Hamsyin

Lecturer of Soil Science Study Program, Faculty of Agriculture,
Mulawarman University, Samarinda.
Email: *hamsyin9@gmail.com*

Correspondencing Author: *Aswin*

Abstract:

This study aims to develop an integrated mechanization model that can improve agricultural production and farmer welfare in East Kalimantan, especially in the context of anticipating population growth in the Indonesian Capital City (IKN). With the relocation of the capital city that will change the demographic landscape, the need for food security is becoming increasingly urgent. The discussion in this study highlights the importance of adopting mechanization technology that not only includes the stages of land cultivation but also the integration of all stages of production from land preparation to post-harvest processing. The research methods used are literature studies and secondary data analysis. Data were obtained from various sources including scientific articles, government reports, and academic publications relevant to agricultural mechanization and agricultural conditions in East Kalimantan. Through this approach, this study successfully identified the needs and potential for implementing integrated mechanization in the region. The results of the study indicate that the application of integrated mechanization can significantly increase harvested area, rice production, and farmer welfare. The adoption of mechanization is not only efficient in terms of time and cost but also allows for the expansion of managed agricultural areas. Supportive government policies, such as subsidies, infrastructure development, and extension and training programs, are needed to accelerate the adoption of this technology in East Kalimantan.

Keywords:

Integrated Mechanization, Agricultural Production, Farmer Welfare, East Kalimantan, Ibu Kota Nusantara (IKN).

I. INTRODUCTION

The relocation of the capital city of the Republic of Indonesia to East Kalimantan will significantly change the demographic landscape of the region, leading to substantial population growth and increased demand for staple foods, especially rice. Currently, rice production in East Kalimantan is insufficient to meet the needs of the existing population, necessitating rice imports from other regions. This underscores the urgent need for strategic interventions to improve local agricultural productivity to ensure food security and economic stability after the relocation of the capital city.

With the vast potential of agricultural land, there is a significant opportunity to increase rice production through the adoption of comprehensive agricultural mechanization. Agricultural mechanization includes the application of machinery, tools, and equipment in the agricultural process to improve productivity, efficiency, and farm management. It covers activities ranging from land preparation, planting, irrigation, pest control, and harvesting, to post-harvest processing and storage. The main objective of agricultural mechanization is to reduce human labor and increase agricultural output through the use of efficient technology.

According to Sharma et al (2021), agricultural mechanization also includes the integration of information and communication technology to optimize agricultural operations. This includes the use of GPS and data analytics to improve management and yields. Sims and Kienzle (2017) emphasized that the adoption of appropriate-scale mechanization tailored to the specific needs and constraints of smallholder farmers is critical to sustainable agricultural development.

The results of the study showed that mechanization can significantly increase agricultural productivity. Studies by Ding et al. (2018) and Bhatt et al. (2019) showed that mechanization can reduce labor costs, increase crop yields, and improve the timeliness of agricultural operations. However, these studies often focus on specific stages of the production process, such as planting or harvesting, rather than a holistic approach that integrates all stages of mechanization. Studies by Sharma et al. (2021) and Zhang et al. (2023) showed that integrated mechanization can substantially increase farmer productivity and income. However, these studies are based on different geographic and socio-economic contexts, highlighting a gap in the literature regarding its application in East Kalimantan.

This study aims to examine integrated mechanization strategies to increase agricultural production and farmer welfare in East Kalimantan.

2. RESEARCH METHOD

This study uses literature study methods and secondary data analysis to identify the needs and potential for implementing integrated mechanization in East Kalimantan. The main data sources include research articles, government reports, and academic publications relevant to agricultural mechanization and agricultural conditions in East Kalimantan.

The literature study approach involves systematic identification, evaluation, and synthesis of relevant research articles, reports, and other academic sources. The literature search strategy was conducted in academic databases such as Google Scholar, JSTOR, ScienceDirect Publish, or Perish and databases.

3. RESULTS AND DISCUSSION

3.1. Rice Production Data in East Kalimantan (2020-2023)

Data from the Central Statistics Agency shows fluctuations in the area of rice harvests in East Kalimantan during the period 2020 to 2023 presented in Table 1.

Table 1. Data on the Development of Harvested Area, Rice Production, and Rice Production in East Kalimantan Province for the Period 2019-2023

Years	Rice Harvest Area (Thousand hectares)	Rice Production (Thousand tons of Dry Milled Paddy)	Rice Production (Thousand tons)
2019	69.71	253.82	146.88
2020	73.57	262.43	151.86
2021	66.27	244.68	142.32
2022	64.97	239.43	139.27
2023	57.08	226.97	132.02

Source: Central Statistics Agency of East Kalimantan Province (Processed)

Based on the data in Table 1, shows that in 2019, the harvested area covered 69.71 thousand hectares; However, over time, the harvested land has changed. In 2020, the harvested area increased to 73.57 thousand hectares; This situation did not last long, namely in the following years, the harvested land began to shrink. In 2021 it was 66.27 thousand hectares, in 2022 it was 64.97 thousand hectares, and in 2023 it was only 57.08 thousand hectares. This decline is not just a number; it is a reflection of the various challenges faced by farmers, from climate change to other technical challenges that affect their productivity.

Just like the area of land planted, rice production also experienced the same thing, namely in 2019 253.82 thousand tons of dry-milled rice were produced, in 2020 the harvest increased to 262.43 thousand tons, in 2021 the area of rice production fell to 244.68 thousand tons, in 2022 production was only 239.43 thousand tons, and finally reached its lowest point in 2023 with 226.97 thousand tons of dry milled rice.

Furthermore, the harvested dry-milled rice is then converted into rice, the data in Table 1 shows that in 2019, rice production reached 146.88 thousand tons, and in 2020, production increased to 151.86 thousand tons. Furthermore, in 2021, 2022 and 2023 rice production continued to decline, namely 142.32 thousand tons; 139.27 thousand tons; and 132.02 thousand tons of rice. This decline is not only a challenge for farmers but also for the entire community who depend on these agricultural products for their daily lives.

3.2. Development of Agricultural Mechanization Equipment

Distribution of agricultural equipment and machinery assistance in East Kalimantan over five years, which reflects the government's priorities and focus on supporting agricultural productivity in the region. Data on the distribution of agricultural equipment and machinery in East Kalimantan during the period 2017-2021 is presented in Table 2.

Table 2. Distribution of Agricultural Tools and Machinery in East Kalimantan Province for the Period 2017-2022

Type of Tools - Machines	Year					Total
	2017	2018	2019	2020	2021	
2 Wheel Tractor (Unit)	243	250	143	54	97	787
4 Wheel Tractor (Unit)	130	155	27	44	71	427
Water Pump (Unit)	205	428	164	73	140	1010
Rice Transplanter (Unit)	20	15	5	5	6	51
Cultivator (Unit)	95	74	13	25	25	229
Hand Sprayer (Unit)	319	243	150	77	77	869

Source: Processed from Ministry of Agriculture's Facilities and Infrastructure Statistics Data 2017-2021

Based on the data in Table 2, shows that the distribution of 2-wheel tractors in East Kalimantan showed a decline from 2017 to 2020, but increased again in 2021. The distribution of 4-wheel tractors is relatively stable with slight fluctuations each year; The distribution of water pump machines increased significantly in 2018 but then decreased in the following years. Rice Transplanters were distributed in small quantities, with a decline in 2020 and a slight increase in 2021. The number of cultivators distributed fluctuated, with a decline in 2019 and an increase in 2020 and 2021; and the distribution of hand sprayers decreased from 2017 to 2021, showing a consistent downward trend.

3.3. Analysis of Mechanization Needs and Potential in East Kalimantan

East Kalimantan has great potential for increasing agricultural production, especially rice, through the application of integrated mechanization. The technology and equipment requirements for each stage of production can be identified as follows: (1) for land preparation, tractors, mechanical plows, and rotavators are needed; (2) for planting, rice planting machines and fertilizer spreading machines are needed; (3) for plant care, spraying machines and drip irrigation are needed; (4) for harvesting, combine harvesters and rice threshing machines are needed; and (5) for post-harvest processing, rice drying machines and rice milling machines are needed.

This situation shows that the adoption of mechanization in East Kalimantan can increase productivity and efficiency in the agricultural sector, especially in rice production. This not only increases yields but also the welfare of farmers through increased income and reduced production costs.

The increase in the number of mechanization equipment in East Kalimantan has a positive contribution to increasing the harvested area and rice production. Mechanization helps reduce operational time and costs, increases the efficiency of the planting, maintenance, and harvesting processes, and improves the quality of the harvest. Thus, agricultural

mechanization not only increases yields per unit area but also allows for the expansion of agricultural areas by opening and managing new land (Wijaya & Nurcahyo, 2022).

According to Hamsyin et al. (2024) the contribution of agricultural tools and machinery to rice production in Kutai Kartanegara Regency, East Kalimantan Province from 2021 to 2022. Each sub-district shows significant differences in terms of changes in rice production and the number of agricultural machinery available, reflecting how agricultural infrastructure plays a role in supporting crop yields.

3.4. Evaluation of Land Potential and Human Resources for Mechanization Implementation

To increase rice production and farmer welfare in East Kalimantan Province, the evaluation of land potential and human resources is a crucial step that cannot be ignored. Agricultural mechanization, which involves the use of tools and machines in the production process, requires suitable land conditions and a workforce with adequate skills and knowledge. Therefore, a thorough analysis of these aspects is essential to ensure the successful implementation of mechanization in this region.

3.4.1. Land suitability assessment

Land suitability assessment is an essential first step in the process of implementing mechanization. Not all types of land are suitable for the use of heavy equipment such as tractors or combine harvesters. Factors such as topography, soil texture, and drainage play an important role in determining whether a land can support the use of agricultural machinery. For example, land with steep slopes or soil that is easily flooded may require modification or special treatment before it can be entered by mechanical equipment. Therefore, a detailed land suitability study needs to be carried out to identify areas that can be optimized for mechanization, as well as to determine remedial measures that may be needed for less suitable land. Quoted from IA, land suitability assessment is important because it can provide information and direction for land use that is by needs. This assessment can also help maintain ecological functions in areas that are vulnerable to damage and natural disasters. The benefits of land suitability assessment are to provide information on actual and potential land conditions and their uses, provide comparative material for planners for alternative land use options, identify limitations that can be improved, determine the ability of the land to provide food to meet the needs of the population in an area within a certain time; and help maintain ecological functions in areas vulnerable to damage and natural disasters (https://www.google.com/search?client=firefox-b-d&q=pentingnya+penilaian+kesesuaian+lahan).

3.4.2. Farmer skills and knowledge

In addition to land suitability, human resource aspects, especially farmer skills and knowledge, are important components in the success of mechanization. Mechanization is not only about the use of tools and machines, but also about the ability of farmers to operate, maintain, and optimize the use of this technology. Education and training for farmers are vital

to improving their skills in the use of mechanical tools. Comprehensive training programs, including introduction to new technologies, machine maintenance methods, and efficient land management techniques, need to be developed and implemented sustainably. In addition, support from experienced agricultural extension workers can help farmers overcome technical challenges that may arise during the mechanization process. Quoted from IA that improving farmers' skills and knowledge in agricultural mechanization is important to increase agricultural productivity and production efficiency. The benefits of improving farmers' skills and knowledge are increasing (agricultural productivity, production efficiency, farmers' profits, the welfare of farmers and their families), reducing production costs, helping farmers face challenges in agriculture, and helping farmers optimize agricultural land (https://www.google.com/search?q=pentingnya+peningkatan+Keterampilan+dan+pengetahuan+petani+dalam+mekanisasi+pertanian).

3.4.3. Infrastructure support

The implementation of agricultural mechanization also depends heavily on the availability and quality of supporting infrastructure, such as access roads to agricultural land, irrigation, and harvest storage facilities. Good and adequate roads allow for the transportation of heavy machinery to agricultural locations, while efficient irrigation systems ensure sufficient water availability to support production. Without adequate infrastructure, even the optimal potential of land and farmer skills may not be fully utilized. Therefore, investment in the development and maintenance of agricultural infrastructure must be a priority to support the success of mechanization in East Kalimantan.

Evaluation of land and human resource potential is the foundation of efforts to increase productivity through agricultural mechanization in East Kalimantan. Careful assessment of land suitability, coupled with improving farmer skills and knowledge, and strengthening infrastructure, will be the main keys to realizing more efficient and sustainable agriculture. Proper implementation of mechanization will not only increase rice production but will also contribute to improving farmer welfare and food security in the region.

Support for agricultural mechanization for food crops is marked by the increasing need for labor in land processing, due to the increasing planting index. In addition, the simultaneity of planting in a large area causes the volume of work to increase, and land processing time becomes shorter so that the demand for labor also increases. The results of the study reported by Hermanto et al (2016) showed that the use of agricultural mechanization tools can increase income which is the accumulation of increased rice productivity, reduced losses, smaller non-labor costs, and reduced use of non-family labor. Saliem et al. (2015) reported similar results. The use of agricultural mechanization tools in a fairly large area provides several benefits in the form of time savings, reduced labor use, reduced costs, increased productivity, and reduced yield losses. In terms of time, the use of agricultural mechanization tools saves quite a lot of time so that simultaneous planting can be carried out.

3.5. Government Policy for Implementation of Integrated Mechanization Model

Some policies proposed to support the implementation of an integrated mechanization model in East Kalimantan include:

(1) Mechanization Subsidies and Incentives, including subsidies for purchasing mechanization tools such as tractors, planting machines, and combine harvesters. Low-interest credit for farmers who want to buy or rent mechanization tools, and tax incentives for companies investing in agricultural mechanization technology.

(2) Agricultural Infrastructure Development, including construction and improvement of infrastructure such as farm roads and irrigation systems; and construction of storage facilities such as warehouses and silos to maintain the quality of the harvest.

(3) Extension and Training Programs, including extension programs to improve farmers' knowledge of mechanization technology and modern agricultural techniques; and training on the use and maintenance of mechanization tools.

(4) Partnerships with the Private Sector, including: encouraging partnerships between farmers and agribusiness companies through the core-plasma model; and cooperation with educational and research institutions to develop and disseminate agricultural technology that is appropriate to local conditions.

(5) Development of Integrated Agribusiness Villages, namely the development of integrated agribusiness villages in pilot areas such as Kutai Kartanegara Regency, North Penajam Paser, Paser, and West Kutai. These agribusiness villages are equipped with facilities for the production, processing, and marketing of agricultural products.

3.6. Detailed Budget Estimate

The budget planning for the integrated mechanization model from upstream to downstream in the rice farming sector involves several important components, from land cultivation to marketing of the harvest. The following is an example of a budget calculation that includes several main elements of agricultural mechanization in East Kalimantan Province, presented in Table 3.

Table 3. Budget Estimate for the Integrated Mechanization Model in East Kalimantan Province

Activities	Equipment Needs	Price (IDR)	Total Cost (IDR)
Land Cultivation	10 units of 2-wheeled Tractors	150.000.000	1.500.000.000
	5 units of 4-wheeled Tractors	350.000.000	1.750.000.000
Rice Planting	Rice transplanter 8 units	80.000.000	640.000.000
Harvest and Post-Harvest	Combine Harvester 4 units	500.000.000	2.000.000.000
	Drying facility 2 units	750.000.000	1.500.000.000

Storage Facilities	Storage facility needed 2 units	1.000.000.0000	2.000.000.000
Distribution and Marketing	Harvest transport truck 5 units	600.000.000	3.000.000.000
Digital and Offline Marketing	Equipment 1 unit	500.000.000	500.000.000
Human Resources Training and Development	Training program and machine operation of 10 sessions	50.000.000	500.000.000
Total Cost Budget			13.390.000.000

Source: Data Processing Results

Based on the budget estimation results in Table 3, it shows that for land processing, a cost of IDR 3,250,000,000 is needed; for rice planting, a cost of IDR 640,000,000 is needed; for harvesting and post-harvesting, a cost of IDR 3,500,000,000 is needed; for storage facilities, a cost of IDR 2,000,000,000 is needed; for distribution and marketing, a cost of IDR 3,000,000,000 is needed; for digital and offline marketing, a cost of IDR 500,000,000 is needed; and for training and HR development activities, a cost of IDR 500,000,000 is needed, so that the total cost is IDR 13,390,000,000. This calculation provides an overview of the amount of investment needed to implement integrated mechanization from upstream to downstream in the rice farming sector. This budget covers all aspects from land processing to marketing, with a focus on increasing efficiency and productivity. Good implementation of mechanization will not only increase the harvest yield but will also encourage the welfare of farmers in East Kalimantan.

Detailed budget estimates for the implementation of the integrated mechanization model in two pilot locations in 4 regencies in East Kalimantan Province, namely: (1) Kutai Kartanegara Regency with a budget of IDR 11.800.000,000; (2) Penajam Paser Utara Regency with a budget of IDR 10.600.000,000; Paser Regency with a budget of IDR 12.400.000,000; and Kutai Barat Regency with a budget of IDR 11.100.000,000, so that from the 4 regencies a budget of IDR 45.900.000,000 is required.

4. CONCLUSION

Based on the results of the analysis and discussion, the following conclusions are drawn:
1. The implementation of an integrated mechanization model in East Kalimantan can be an effective strategy to increase agricultural production and farmer welfare.
2. Comprehensive government policy support, including subsidies, infrastructure development, extension and training programs, and partnerships with the private sector, are expected to increase regional food security and support the New Capital City of Ibu Kota Nusantara (IKN).

REFERENCES

BOOKS AND JOURNAL

Central Bureau of Statistics 2022. East Kalimantan Agricultural Statistics. Samarinda: Central Bureau of Statistics of East Kalimantan.

Central Bureau of Statistics 2023. Harvested Area and Rice Production in East Kalimantan Province. Samarinda: Central Bureau of Statistics of East Kalimantan.

Bhatt, R., Sharma, M., & Singh, R. 2019. The Role of Mechanization in Agricultural Productivity. International Journal of Agricultural Sciences, 17(3), 567-578.

Food, Food Crops, and Horticulture Service of East Kalimantan Province. 2020. Annual Report of the Food and TPH Service of East Kalimantan. Samarinda: Food and TPH Service of East Kalimantan.

Food, Food Crops, and Horticulture Service of East Kalimantan Province. 2022. Analysis of Agricultural Land Suitability in East Kalimantan. Samarinda: Food and TPH Service of East Kalimantan.

Food, Food Crops, and Horticulture Service of East Kalimantan Province. 2023. Annual Report of the East Kalimantan Food and TPH Service. Samarinda: East Kalimantan Food and TPH Service.

Ding, Q., Wang, H., & Zhang, Y. 2018. Agricultural Mechanization and Its Impact on Productivity. Agricultural Economics, 49(4): 491-503.

Hamsyin, M., Yuliani, E., & Adi, W. 2024. Strategy for Increasing Farmer Capacity in East Kalimantan. Journal of Rural Development, 13(1): 89-102.

Hermanto, Mayrowani H, Prabowo A, Aldillah R, Soeprapto D. 2016. Evaluation of Design, Implementation, and Impact of Mechanization Assistance on Accelerating Increased Production of Rice, Corn and Soybeans. Final Research Report of the Center for Socio-Economic and Agricultural Policy, Bogor.

Saliem HP, Kariyasa K, Mayrowani H, Agustian A, Friyatno S, Sunarsih. 2015. Prospects for Modern Agricultural Development Through the Use of Agricultural Mechanization Technology in Lowland Rice Fields. Policy Analysis Report of the Center for Socio-Economic and Agricultural Policy, Bogor.

Sharma, S., R. Sharma., K. Dev., and Samriti. 2021. Economic Analysis and Mechanization Index of Agricultural Crops In Mandi District of Himachal Pradesh. Economic Affairs. 66 (1)

Sims, B. G., & Kienzle, J. 2016. Making Mechanization Accessible to Smallholder Farmers in Sub-Saharan Africa. Environments, 3(3),: 1- 11.

Wijaya, A., & Nurcahyo, R. (2022). Agricultural Mechanization in Indonesia and Comparison to Southeast Asia Countries. Proceedings of the International Conference on Industrial Engineering and Operations Management.

Zhang, H., Z. Yang, Y. Wang, A. Twumasi M, and A.A. Chandio. 2023. Impact of Agricultural Mechanization Level on Farmer's Health Status In Western China. Analysis Based on CHARLS. International Journal of Environmental Research and Public Health. 20(5) 46-54.

DOWNLOAD OF IA

https://www.google.com/search?client=firefox-b-d&q=importance+of+land+suitability+assessment. Accessed, February 28, 2025

https://www.google.com/search?q=importance+of+improving+farmers+skills+and+knowledge+in+agricultural+mechanization. Accessed February 28, 2025