

Implementation of technology 4.0 in achieving the effectivity and efficiency of the production process in palm oil plantation

Lili Dahliani^{1*}, Sutria Wirandayu¹, and M Dewantara¹

¹ Technology and Management of Plantation Production Department, College of Vocational Studies, IPB University, 16128 Bogor, Indonesia

^{1*}Corresponding author: lilidahliani@apps.ipb.ac.id

Abstract. Palm oil (*Elaeis guineensis* Jacq.) is a plantation commodity that has a role in the Indonesian economy. The area of palm oil plantations in Indonesia reaches 14,300,000 hectares with 43,000,000 tons of *Crude Palm Oil* (CPO) production. The implementation of technology 4.0 on palm oil production is needed not only for technology innovation, but also for effectivity and efficiency on production process. This research aims to study the efficiency of resources use and the effectivity of output achievement on palm oil production. This research was done descriptively and quantitatively using primary data, which was direct interviews with the people who works in palm oil plantations, and the secondary data was obtained from research results, plantation company's yearly report, and other literature review. The research result showed that the implementation of technology 4.0 on the recording of employee attendance register and calculation of harvest density rate (HDR) including field and fruit quality was more efficient 25-50% in use of employee and time. The implementation of technology 4.0 was also more effective in achieving output compared to the manual method. The conclusion of this research is the implementation of technology 4.0 on some production process in palm oil plantation is more effective and efficient compared to the manual method. The starting budget on implementing technology 4.0 is higher by 30% compared to the manual method, but it becomes ten times cheaper on the next maintenance cost.

Keywords : palm oil, plantation commodity, technology 4.0, effectivity, efficiency

1 Introduction

Palm oil (*Elaeis guineensis* Jacq) is one of the mainstay plantation commodities that has a positive and impacts and benefit on the Indonesian economy and creates a multiplier effect. Those benefits are contributing to foreign exchange earnings, providing employment and sources of farmers income, generating regional original income, contributing to the development of the area and producing region, producing gross domestic product, and accelerating of community economic development to alleviate poverty in rural areas [3, 4, 8]. Although palm oil plantations lead to a decrease in the level of interaction and mutual

assistance, they contribute greatly to the provision of public facilities and education in the community [5]. Palm oil plantation development activities have resulted in high population mobility, the emergence of centers of economic growth, the circulation of money in rural areas, especially for routine household needs and the need for production facilities, as well as the growth of trade and services [8]. Palm oil is classified as a more effective crop in terms of land use, productivity and marketing, which can help reduce dependence on fossil fuels [1].

Total oil and palm kernel production were 51.443.315 tons in 2019. The national export volume of palm oil in 2019 was 29.135.179 tons with a value of 20.802.708.000 US\$. Palm oil plantations in Indonesia are carried out by large state plantations (PBN), large private plantations (PBS), and smallholder plantations (PR). The area of Indonesia's oil palm plantations according to the estimated 2019 data is 14.677.560 ha, of which the PR area is 41% of the total oil palm area. Palm oil production from smallholders' plantations in the same year was 14.846.112 tons, which is 16% of national production [2].

Palm oil development strategy is very necessary considering the increasingly competitive global market competition. One of strategy that is able to increase competitiveness is a program to increase added value through innovation and industry technology 4.0 to increase productivity through innovation and technology plays a role in increasing productivity. The application of technology will strengthen the sustainability of the industry, including the palm oil industry. Digital technology has made many jobs easier in the palm oil industry. The leading cloud service provider in Indonesia, Datacomm Cloud Business together with partners, introduced the SMART AGRICULTURE Integrated Plantation Digital solution for plantations in general and Palm Oil plantations. Smart Agriculture supports Industry 4.0 and the Sustainable Development Goals.

Indonesia has compiled an industry 4.0 roadmap by specifying five manufacturing sectors which will be the main priority in its development. One of them is the agricultural sector that included in the food and beverages sector [7].

2 Method

This research was conducted in a palm oil plantation located in Labuhan Batu and South Tapanuli regency, North Sumatra, Indonesia. The determination of the research location was done intentionally, with the consideration that the location was a place for field work practice for students who majoring in Technology and Management of Plantation Production, College of Vocational Studies, IPB University. The research of technology 4.0 application was carried out both in the plantation production subsystem (on-farm) and in the processing plant production subsystem (off-farm). The research was conducted from February to April 2021.

The data obtained in this study were primary data and secondary data. Primary data was obtained from the results of student interviews and direct observations during the implementation of field work practices in the oil palm plantation. Secondary data, apart from being obtained from reports from the management of the oil palm plantation office in the research area, also came from literature studies and the results of previous studies. Interviews were conducted with plantation officials, which the assistant head (deputy manager of the plantation) and the head of the plantation division.

Data analysis used quantitative and qualitative methods. Qualitative data was obtained by the interviews with palm oil production actors in the palm oil plantation area. Meanwhile,

the quantitative data was the research results that processed into a result of understanding and analysis then added with the results of existing research. The data also used primary and secondary data which was obtained directly from respondents and literature that already existed before.

3 Results and Discussion

The results show that technology 4.0 has been applied in oil palm plantations, both in the plantation production subsystem (on-farm) and in the processing plant production subsystem (off-farm). The application of technology 4.0 in the on-farm palm oil production subsystem only includes in several palm oil cultivation activities, such as calculation/compilation of harvest density rate (HDR), recording of employee attendance, recording of harvest yields along with recording of field quality and fruit quality. The application of technology 4.0 in the palm oil production subsystem is even implemented starting from the initial station for processing Fresh Fruit Bunches (FFB) into CPO to the final station, the oil refining station. One of the considerations the palm oil plantations management in implementing technology 4.0, is to obtain the value of efficiency and effectivity. The results of this study indicate that the use of technology 4.0 in palm oil plantations, especially on-farm, makes the use of resources such as time and human resources (HR) more efficient and achieves the effectiveness of the objectives of the activities in the production subsystem.

3.1 Effectivity and efficiency

Recording of employee attendance register, harvest recording, measurement and calculation of harvest density rate including field quality and fruit quality in palm oil plantations that apply 4.0 technology requires smaller resources rather than doing it manually. Referring to the environment and the principle of paper less, the application of technology 4.0 in palm oil plantations makes minimal use of paper for recording and reporting. The manual system produces waste in the form of paper, while using the 4.0 system it does not produce waste so it is more efficient than the manual system. Further explanation of the efficiency and effectivity of the application of technology 4.0 compared to manual implementation is shown in Table 1 and Table 2.

Table 1 Implementation of technology 4.0 on harvest density rate calculation and recording of employee attendance register

Activity	Manual	Technology 4.0
Harvest density rate (HDR) calculation	Time	
	1,5 hours for 150 plants	1 hour for 150 plants
	HR	
	2 people per 300 plants	1 person per 300 plants
	Tools	
	Office stationery : Rp 100.000 - 150.000 per month	Gadget : Rp 2.000.000 Maintenance : Rp 100.000 - 150.000 per mont
Recording of employee attendance register	Time	
	Takes more time	Takes less time
	HR	
	> 2 people	1 person

Table 2 Implementation of technology 4.0 on harvest record, harvest field quality, and harvest fruit quality

Activity	Manual	Technology 4.0
Harvest record	Time	
	Input data in the office before it becomes harvest record information	faster data entry
	HR	
	3 people	2 people
Harvest field quality	Time	
	Input data in the office before it becomes quality information	field quality information is directly received by decision makers
	HR	
	2 people	1 person
Harvest fruit quality	Time	
	Input data in the office before it becomes quality information	fruit quality information is directly received by decision makers
	HR	
	3 people	2 people
	Tools	
	Office stationery : Rp. 150.000 per month	Gadgets : Rp. 1.950.000 Maintenance : Rp. 100.000 per 3 months
	Tools	
	Office stationery : Rp. 150.000 per month	Gadgets : Rp. 1.950.000 Maintenance : Rp. 100.000 per 3 months

Based on the Tables 1 and Tables 2, it shows that the application of technology 4.0 makes the use of resources such as employees, time, and costs is more efficient 25 - 50% with the assumption that the application of technology 4.0 are already owned by palm oil plantations.

3.2 Problems and Solutions

The application of technology 4.0 will be efficient and effective if the management of palm oil plantations both on-farm and off-farm can provide solutions to the existing problem. Especially on the on-farm, the performance of the gadgets can be errors or glitch. Another problem that encountered in the application of technology 4.0 is unstable signal or lost signal for one reason or another. The results of Dahliani's research, show that signal problems that often occur on cellphones such as lost signal, changing signal display (signal drop), unstable signal or full signal but unable to make calls (pseudo signal) [6]. To find out

signal problems that occur in cellphone hardware, it is necessary to check the Tx and Rx circuits, CPU circuits related to signal processing and voltage distribution from the IC Power Supply to those circuits. The inspection process includes checking the path between components, measuring voltage and frequency on components related to the process of transmitting and receiving signals. By analyzing the indications/characteristics of the problem and the results of the examination of signal problems with the theory and function of each cell phone component related to signal processing, it can be found out the cause of the problem and the appropriate treatment can be carried out according to the problem.

Telecommunications observers said that the signal condition was determined by the condition of the cellular operator's Base Transceiver Station (BTS). The BTS power source is electricity from PLN. BTS is a telecommunications infrastructure that is used as a transmitter and receiver of cellular networks in one area coverage. BTS converts the transmitted and received signals into digital signals. These signals are then sent to other terminals for the circulation of messages or data. PLN electricity is required to power the entire BTS system.

Errors in inputting data are also one of the problems encountered in the application of technology 4.0 in oil palm plantations. This error results in data inaccuracies, which one of the causes is poor or unstable signal conditions. Data is one of the 5 core technologies that are the main pillars in developing technology 4.0 to be a digital-ready industry, in addition to : Internet of Things (IoT), Artificial Intelligence (AI), Cloud Computing and Additive Manufacturing. The skills of employees or palm oil plantation officers in operating gadgets are also one of the problems that encounter in the application of technology 4.0. Employees must be reliable in the operation of gadgets, especially in inputting data from the field so that the right information will be produced to support management decisions.

Solutions for the performance of the gadgets used, related to unstable signal reception and even no signal at all, need to be done so that delays in uploading daily data information can be overcome. One of the solutions is developing internet network infrastructure for remote areas by collaborating with parties providers. Dahliani explained that signal problems that often occur in plantation areas including palm oil plantations are signal loss, signal display changes (drop signal), unstable signal and full signal but cannot make calls (pseudo signal) [6]. One solution is to install signal amplifiers in oil palm plantation areas.

The low performance of the gadget is sometimes caused by the specifications not match with the required capacity; therefore gadgets need to be upgraded with more complete specifications according to camera needs. The solutions of employees or workers who have not mastered gadget operations, they need to be given training in using gadgets and applications.

4 Conclusion

Based on the results of research and discussion in the previous section, it can be concluded that:

1. Technology 4.0 in oil palm plantations in the research locations, has been applied both in the plantation production subsystem (on-farm) and in the CPO processing plant production subsystem (off-farm).
2. Technology 4.0 in the plantation production subsystem (on-farm) at the research location was applied in the following activities: measurement and calculation of harvest density rate (HDR), recording of harvest yields along with recording of field quality and fruit quality, and recording of employee attendance register. The implementation of

technology 4.0 in off-farm is starting from the boiling station to the oil purification station.

3. The use of technology 4.0 is more efficient in the use of resources such as time, employees, tools, and is more effective in achieving goals. All of that efficiency and effectivity can be achieved if the management of palm oil plantations can provide solutions to the problems that encountered in the application of technology 4.0.

References

1. C.H. Lim, S. Lim, B.S. How, W.P.Q. Ng, S.L. Ngan, W.D. Leong, H.L. Lam, *A review of industry 4.0 revolution potential in a sustainable and renewable palm oil industry: HAZOP approach*. Renewable and Sustainable Energy Reviews, 135, p.110223 (2021)
2. Directorate General of Estate Crops, *Tree Crops Estate Statistics of Indonesia 2018 - 202*, 26 (2019)
3. F. Firman, A. Suyatno, D. Kurniati, *Analysis of Income Level And Welfare of Oil Palm Farmers in Merarai Village, Sungai Tebelian District, Sintang Regency*, Tropical Plantations and Land, 8(2), pp.61-66 <http://dx.doi.org/10.26418/plt.v8i2.29799> (2018)
4. I. Darwis, *Impact of the existence of oil palm companies on the social welfare of the community in Bulu Mario village Nort Mamuju Regency* (2015)
5. I. Siradjuddin, *Impact of palm oil plantation on the regional economy in the district of Rokan Hulu*, Journal of Agrotechnology, 5 (2) 7-14 (2015)
6. L. Dahliani, *Implementation of Study From Home Activities in IPB Vocational School Study Program Technology and Management of Plantation Production in the Covid and New Normal Era*, New Normal Multidisciplinary Study, Psychology Forum and AMCA (2020)
7. N. Haryanti, A. Marsono, M.A. Sona, *Implementation strategy for oil palm plantation development in the 4.0 industrial era*, Journal of sharia economic dynamics, 8 (1), 76-87 <https://doi.org/10.53429/jdes.v8i1.146> (2021)
8. Z. Nasution, *Analysis of palm oil commodity and its economic impact on the wefare of the community in the district Labuhan Batu* . Journal of Ecobisma 2(1) (2015)