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Use of modern technology and innovations to increase the productivity of oil palm smallholders

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ABSTRACT

There is an increasing application of technology in the agriculture industry as more innovative inventions become available. The Malaysian government, through MPOB, renders assistance to oil palm smallholders in the adoption of suitable modern technology while providing them technical advisory services either directly or indirectly. Nonetheless, the question remains as to whether the application of such technology has achieved its objective of increasing smallholder productivity in terms of crop and labor input requirements. Therefore, the purpose of this study is to identify the use of modern technology and innovation in increasing the productivity of smallholders in Banting, Selangor. This study employed a quantitative method based on correlation analyses. A total of 167 respondents were sampled. The results showed that the first questionnaire statement, namely 'Application of modern technology eases work in palm oil production' attained a mean score of 4.32, corresponding to an opinion 'Strongly agree' reached by 77 or 46.1% of the respondents. The analysis of this statement clearly shows that the application of modern technology in the oil palm plantation sector facilitates most of the work in oil palm plantations. This study is different from the other study because it shows which statement makes smallholders accept modern technology in their oil palm plantations to increase the productivity of yields and incomes. Therefore, the use of technology should be practiced by all smallholders in Malaysia to increase their productivity of smallholders.

1. Introduction

The cultivation of oil palm is an activity that has contributed substantially to the economy of Malaysia. Commercial planting of oil palm has been undertaken since the time of the British in Malaya. Selvadurai et al. (2018) attributed the importance of the industry to the many diverse uses of palm oil, such as for cooking, industrial applications, or as an energy source (biofuel). Palm oil plays an important role in our livelihoods, being a source of food and as a raw material for the manufacturing sector the world over. Moreover, as it affords employment both in its planting and processing, the palm oil industry is a crucial economic component of many developing countries.

As an inexpensive vegetable oil, palm oil has found a market in many countries. According to Asnari and Wahid (2018), much effort has been made by the government to expand the export of Malaysian palm oil to European countries with the Malaysian Sustainable Palm Oil (MSPO) certification. In this regard, it has been impressed upon palm oil producers the need to maintain high standards in cultivation and processing to ensure good and sustainable practices are in place to safeguard the image of this Malaysian product. Notwithstanding some unfriendly media reports to the contrary, oil

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palm cultivation in Malaysia is undertaken in an environment-friendly manner. With many countries in Europe being important trading partners, oil palm smallholders need to observe crop sustainability, a practice that is expected by the importer.

Government intervention has resulted in wide-scale cultivation of oil palm in regions where the crop thrives well. The global demand for palm oil, both as a food product and as a non-food product, has attracted many investors to seek good returns within a relatively short period, thus resulting in the rapid growth of the industry (Er and Siwar, 2015). Cultivation of oil palm in an ecologically friendly manner remains one sector of agriculture where sustainability is of prime concern. To this end, management in the palm oil industry is systematically geared towards high production, while keeping an eye on costs and risk control. Overall, this will lead to increased productivity, operational safety, better workers' welfare, and protection of the environment.

In response to the need for uptake of agriculture technology, the Malaysian Palm Oil Board (MPOB) set up the TUNAS Centre in 2002 aimed at providing training and advice to independent oil palm smallholders to enhance productivity and ensure production sustainability. Moreover, its Integration and Development Research Division has been charged with the responsibility to transfer technology and implement the government aid scheme for oil palm smallholders (Hashim et al., 2014). In this regard, training courses for technology transfer have also been organized. The majority of smallholders require training in crop production, harvest techniques, preparation of stimulants, and improved farming techniques that will increase production (Aurelie et al., 2010). Pemsl et al. (2006) showed that a training and guidance program for farmers would help the dissemination of agricultural knowledge that would ultimately raise the productivity and income of farmers.

In Malaysia, much agricultural activity today revolves around the use of modern technology to attain the desired output. Among examples of such agricultural technology are modern machinery, chemical fertilizers, and equipment to produce improved seed stock and planting materials. Othman (2009) noted that the government and private sector have taken various steps and approaches towards raising the quality of agricultural output of the country by emphasizing efficiency through the application of technology. Work in the field such as land clearing, preparation of planting materials, and harvesting is simplified and has become more systematic, resulting in savings of time and effort. In general, the problems facing oil palm smallholders arise largely from a lack of suitable technology, soil fertility issues, and low fresh fruit bunch productivity. Nevertheless, with expanding oil palm technology introduced via TUNAS, smallholders are provided with the proper guidance to adopt good agriculture practices (Peng et al., 2020). Scientists and technologists are frequently involved in research to invent modern equipment for the agriculture sector. Existing machinery and equipment are continually being modified and upgraded. In oil palm research, scientists are coming up with new cultivars of oil palm and better fertilizers that can induce more vigorous growth to hasten the maturity of young palms. It is, nonetheless, important to examine whether the efforts to encourage the adoption of modern technology and innovations are actually paying off, i.e., the question that needs to be asked is this: Has the productivity of oil palm smallholders been increased as a result of the adoption of technology and innovations?

2. Literature review

Technology is today recognized as a strategic element in raising the competitiveness of a country's economy. This is undoubtedly true of the palm oil industry where modern technology plays a crucial role in aiding industry workers as they perform their duties. The relevant technologies in the palm oil industry are varied, and they include planting materials, field machinery, fertilizers, factory equipment, and so forth. Technology is the result of man's ingenuity that facilitates and simplifies his activities. Especially in this era of globalization, technology cannot be divorced from everyday life, with its ubiquity reflecting our day-to-day living dependency on it. Among the areas that harness technology is education, transport, medicine, food, economy, agriculture, and so forth. Technology itself encompasses very broad aspects that involve machinery, miscellaneous inventions, and their modifications. Mathematicians, scientists, and researchers in various disciplines provide the necessary input to make advancements in technology to benefit mankind. Technology can be viewed as an object, an ingredient, and a form that is prone to change with man's changing needs. Hence, technology also has the means to shape and change the culture.

Today's fast progressing technology represents a totality of the ways by which innovations provide the means to enrich and ease human living. The application of the technology would have begun with simple tools crafted as aids for everyday convenience. From there, innovation takes technology to a level that now pervades all aspects of human activity. The technological developments have given rise to a new generation or even a new civilization, and have engulfed all aspects of community life. Malaysia, like the rest of the world, has benefitted greatly from technological advancements. Nonetheless, technology brings with it both benefits and detriment, instruments of war being examples of the latter. As a less grim example, the invention of smartphones has greatly facilitated communication and the sharing of knowledge. But overuse or over-reliance on this technology, especially among youths, has many deleterious effects. Nevertheless, one benefit of such

development to youths is the fact that they have to acquire a level of expertise to fully exploit the many applications (apps) the smartphone can offer. It is, therefore, a matter of making the most of the benefits technology brings to the user.

Ardana and Kariyasa (2016) examined the impact of the application of technology on the palm oil industry and concluded that it helped considerably in the selection of superior planting materials, thus leading to higher yield. It is the planting material that determines whether the subsequent product is of high quality; this is what will ultimately be responsible for the smallholder's productivity and income. Shuib et al. (2011) proposed several aspects of modern technology applicable in the industry, starting from equipment and machinery that eases the workload of workers while increasing their productivity. MPOB and the oil palm planting industry as a whole have introduced a slew of technologies that begin with land clearing and planting, and later, transporting fruit bunches all the way to the factory. Sowat et al. (2018) are of the view that new technology applied in harvesting will benefit smallholders greatly. Such innovation will help save time and money as the number of workers is reduced; worker injury can also be minimized. One proposal is a small, portable climbing robot to harvest oil palm fruits. While current research indicates that the potential of such an invention can be substantial, its development is still in its early stages.

The many facets of modern technologies in the palm oil industry include planting, agronomy, and harvesting. Feedback from oil palm growers indicates that modern technology has changed the management and operation of oil palm cultivation to increase productivity. Mohd Nawi et al. (2018) clarified that the technology used in harvesting oil palm bunches includes collecting loose oil palm fruits, transferring the harvest to lorries for transportation to the factory while the technology for application in field operations includes fertilizer application, pest and disease control, and the cutting of palm fronds. Such applications of technological innovations have contributed immensely to the development of the palm oil sector in Malaysia.

Technology in the palm oil industry is not confined to the collection, pruning, harvesting, and seed production, but extends to aerial spraying of chemicals that are potentially poisonous. Goh et al. (2019) estimated that 7 million hectares of oil palm in Malaysia are known to have conducted aerial spraying in the past ten years, this operation having been monopolized by Systematic Aviation Services Sdn. Bhd. (SAS). Such spraying has been deemed effective in controlling insects and viruses in oil palm planting. It is also time-saving and does not damage the plants although there are those who are concerned over the issue of potential toxicity.

TUNAS is charged with the responsibility to transfer technology to oil palm smallholders in Malaysia. According to Yusof et al. (2016), TUNAS is doing a creditable job with regard to communication, knowledge, attitude, and leadership besides demonstration of technical procedures. The advice provided is put into practice by smallholders. While there are still small segments of farmers who are not bothered with pest and parasite control, officers from TUNAS constantly monitor the situation and provide the appropriate best practice advice to correct shortcomings.

2.1. Effect of modern technology on the cultivation of oil palm

The adoption of modern technology in agriculture is on the rise. This transformation should be encouraged and supported, especially in the oil palm sector, to explore the full potential riding on this wave of technological expansion. Nevertheless, technology has both positive and negative impacts as mentioned earlier. Agricultural technology would encompass machinery, procedures, skills and techniques for the production, and physical means in arriving at a solution (Aziz, 1986). The application of technology in the agriculture sector is essentially equipping the farmer or grower with the requisite knowledge and means to meet his needs more efficiently.

The Malaysian Palm Oil Board, through its Integration and Development Research Division, which has been tasked with the responsibility of technology transfer to oil palm smallholders (Hashim et al., 2014), provides current information and technology related to oil palm planting and appoints a developmental agent to initiate and implement the development of technology transfer related activities. The agent, as a TUNAS representative, would carry out the activities in his assigned area. In this manner, the productivity of the smallholders is raised, and their income effectively increased (Hashim et al., 2014). MPOB Director-General Dr. Ahmad Parveez Ghulam Kadir took great pride in the success of technological innovations in all sectors of the Malaysian oil palm industry; 667 technologies had been initiated and launched during the past 20 years. He informed the Bernama News Agency that the development of farming machinery and its use in oil palm planting had enhanced the efficiency of field operations in the harvesting of fruit bunches, collection, and packing of loose fruits as well as their transportation within the farm. As a result, the productivity of workers and farm management had improved considerably.

2.2. Quality product output

Azian et al. (2017) viewed it essential that the development of palm oil output should be a sustainable endeavor. To this end, factors that need to be taken into consideration include restoration of soil fertility, adequacy of plant nutrients and water supply, and protection against pests and diseases. The use of appropriate technology would help to ensure all these considerations. High productivity also depended on the location of the land (climate

and topography), type of planting material (selected seedlings, tissue culture), technical management (finance, organization, labor, transportation, pests, and diseases), harvest (efficiency in harvest procedure), and environment protection (disposal and recycling of wastes). Indeed, it can be said that the transfer of technology related to sustainability has successfully increased productivity in the industry (Paramananthan and Sen, 2000).

Fertilizers, formulated for oil palm cultivation and developed through research, make use of modern technology. Such fertilizers contribute to the health and vigor of the palm. For example, phosphate in the fertilizer compound enhances the health of the plant while it enriches the soil. Appropriate fertilizing ensures the production of fruits of consistently high quality. MPOB undertakes ongoing research to formulate both chemical and organic fertilizers to nurture the oil palm according to established rates and management schedules. The result is a crop that is well received in the market.

The use of advanced technology increases agricultural yields. This is because most foreign investors are interested in developing oil palm and commodity industrial lands in other countries in Malaysia. Apart from that, the oil palm industry is also constantly studying new technologies in agriculture to increase production in the oil palm sector. In addition, the use of chemical fertilizers produced using advanced technology is able to provide adequate nutrients to oil palm trees. With this, oil palm trees are able to produce oil palm bunches of large size and high weight. The palm fruit will also have a good quantity of oil and meet the criteria for exporting.

2.3. Addressing environmental pollution

The benefits of oil palm planting also bring with it effects adverse to the industry, especially environmental pollution. Some oil palm growers are thought to use poisonous chemicals to control pests and diseases, and this is tantamount to poisoning the land. The alkalinity of the soil increases, sometimes making it less suited to replanting the crop. Moreover, various contaminants in the soil are washed down with rainwater, resulting in pollution of the waterways. Such water pollution results in the death of fish and other aquatic life. People living by such compromised rivers also find it difficult in obtaining clean water supplies. To alleviate such problems, the authorities frequently monitor the quality of water in rivers. It must be noted that rehabilitation of polluted waterways is not only difficult but also very costly.

Large-scale planting of oil palm in the tropics has given rise to concerns about its impact on the environment. Such activity involves the clearing of the jungle, destruction of the natural habitat and biodiversity, and invokes changes to the global climate (Rist et al., 2010). This perception has found traction with Khan et al. (2009) who see a rapid expansion of oil palm cultivation as a path to unbridled industrialization, land grabbing, and extensive clearing of forests. Many Non-Governmental Organizations (NGOs) have made similar observations regarding the negative impact on the environment, including the potential extinction of native flora and fauna. The response to such concerns has been the setting up of oil palm technical advisory centers all over the country to promote national palm oil production in a sustainable manner (Azizan et al., 2012). Other than that, the government should consider setting up wildlife protection centers that collaborate with various agencies in the palm oil industry; the Forestry Department of each state could also play an active role in the conservation efforts (Azizan et al., 2012).

Over and above the 60% land area of Malaysia held as permanent forest reserves, oil palm that covers the land is arguably a form of vegetative cover, and it is debatable if it really constitutes ecosystem destruction (Choy et al., 2012). Oil palm can, in fact, be perceived as a kind of secondary forest that serves as lungs for the environment. Moreover, larger plantation agencies like Sime Darby have instituted a zero-burning policy in their replanting programs (Er et al., 2012), burnishing their eco-friendly credentials.

Various forms of certification of sustainability–Certified Sustainable Palm Oil (CSPO), Round Table Sustainable Palm Oil (RSPO), and Malaysian Sustainable Palm Oil (MSPO)–benefit producers although many smallholders remain cautious and constrained because of the costs involved in such certification. The same constraints are felt by other agencies as well. Yet it is with such certification that Malaysian palm oil can penetrate international markets. This is an ongoing problem that is likely to haunt the palm oil industry into the future (Hafizuddin-Syah et al., 2018).

3. Methodology

A quantitative approach based on correlation analyses was used in this study. The sampling procedure involved a stratified sampling. The focus of this study was more on specific participants who were oil palm smallholders involved in using modern technology and innovations to increase productivity. To determine the sample size, the method of Krejcie and Morgan (1970) was employed since it was applicable to a large sample. The final sample that comprised 167 participants from four smallholdings in Banting in the state of Selangor was expected to give a reliable study outcome.

This study was undertaken using questionnaires that comprised two sections, A and B. Section A concerning demographic information, viz. gender, age, marital status, number of household members, ethnicity, religion, and period of working in the oil palm smallholding. Section B carried the questionnaire statements that were related to the objective of the study to determine the perception of smallholders towards the use of modern technology

in oil palm planting. The questionnaire was designed to elicit information on productivity resulting from adopting modern technology and innovations in the management of the smallholding. The participants indicated their opinions via a five-point Likert scale with scores of 1 (Strongly disagree), 2 (Disagree), 3 (Neutral), 4 (Agree), and 5 (Strongly agree).

4. Study findings

The study results were from 167 respondents from Banting, Selangor who had been confirmed to be involved in the use of modern technology and innovations in their smallholdings. The findings from the analysis of the results are described here.

4.1. Demography

In Section A of the questionnaire, data from the respondents were analyzed with respect to their demography and background (Table 1). The demographic information included gender, age, marital status, household number, ethnicity, religion, education level, and years of service in the oil palm sector. There were 125 male respondents, making up 74.9% of the participants who were all aged 15 and above (Table 1). The largest age group included those between 21–40 years of age who comprised 42 respondents, or 25.1%. The oldest respondents, of which there were two (1.2%), were aged 61 or older. Married participants (94) made up 56.3%, whereas there were eleven respondents who were separated and they comprised 6.6%.

The largest households were those with 4 to 6 persons, and they comprised 47.3% or 79 persons. The largest number of participants came from the Indian community. The 69 of them made up 41.3% of the sample, and the group was responsible for the Hinduism religion making up the biggest group by religion (68 persons, 40.7%). Nine percent (15 persons) of the participants were of religions other than Hinduism, Islam, or Buddhism. This study went on to examine the educational level of the respondents.

It can be seen from Table 1 that those with SPM qualifications made up the largest group. There were 74 respondents making up 44.3% of the study sample. The experience of the respondents in the oil palm industry varied from one or two years to beyond five years. The latter group consisting of 63 persons (37.7%) was the largest.

Table 1: Demography

	Demography		(N)	(%)
1	Gender	Male	125	74.9
		Female	42	25.1
2	Age	15-25 years	33	19.8
		26-30 years	41	24.6
		31-40 years	42	25.1
		41-50 years	35	21.0
		51-60 years	14	8.4
		61 years and above	2	1.2
3	Marital status	Widow/widower	14	8.4
		Separated	11	6.6
		Married	94	56.3
		Unmarried	48	28.7
4	Number in the household	1 to 3 persons	54	32.3
		4 to 6 persons	79	47.3
		7 to 9 persons	26	15.6
		10 persons and above	8	4.8
5	Ethnicity	Malay	61	36.5
		Chinese	13	13.8
		Indian	69	41.3
		Others	14	8.4
6	Religion	Islam	61	36.5
		Hindu	68	40.7
		Buddhism	23	13.8
		Others	15	9.0
7	Education level	SRP/PMR/PT3	44	26.3
		SPM	74	44.3
		STPM	31	18.6
		Diploma	9	5.4
		Degree	9	5.4
8	Period of involvement in oil palm planting	1 to 2 years	54	32.3
		2 to 4 years	50	29.9
		5 years and above	63	37.7

4.2. Application of modern technology and innovations in raising productivity

In Section B of the questionnaire, productivity is taken as the measurement of efficiency and effectiveness in producing an output from a given set of inputs with respect to optimal use of a resource such as labor, technology, system etc. to increase productivity. It is also of paramount importance to maintain high quality of the palm fruit to ensure successful marketing of palm oil worldwide.

It would appear from the questionnaire analysis that the application of modern technology in the field had succeeded in increasing productivity. All components of 'productivity' taken together in this survey attained an overall mean score of 4.20 out of 5.

In Table 2, the first statement of the questionnaire, viz. 'the use of modern technology eases works in palm oil production', garnered a mean score of 4.32, with 'Strongly agree' responses reaching 46.1% (77 respondents). The second highest opinion was 'Agree', with 43.7% (73 persons). 'Neutral' attained 7.2% (12 respondents), followed by 'Disagree' by four respondents (2.4%). The response to "Strongly disagree" garnered only 0.6% (1 person). The analysis applied to this statement showed clearly that the application of modern technology eased the work involved in the production of palm oil in smallholdings.

The second statement in the questionnaire was about 'technology raising the quality and standard of palm oil'; a mean score of 4.21 was attained. The opinion most frequently picked was 'Agree' by 71 respondents (42.5%). The next most favored opinion was 'Strongly agree', the decision of 69 respondents representing 41.3% of the study sample. After this came the 'Neutral' group of 13.2% (22 persons). 'Disagree' and 'Strongly disagree' rounded up the opinions with those views held by three persons (1.8%) and two persons (1.2%) respectively. This analysis showed that the respondents were convinced that the application of technology was successful in raising the quality and standard of palm oil.

The third statement in the questionnaire suggests that 'technology raises production of oil palm fruits consistently'. The mean score here was 4.14, with the most frequently expressed opinion being 'Agree' held by 73 respondents (43.7%). 'Strongly agree' was the opinion held by 64 participants (38.3%). The 'Neutral' group comprised 23 persons or 13.8% of the study population. This was followed by the four participants (2.4%) who disagreed that technology had that purported effect. Only three respondents (1.8%) strongly disagreed. In this analysis again, it is clear that the respondents felt that technology had raised the production of oil palm fruits consistently on their farms in Banting, Selangor.

The fourth questionnaire statement declaring that technology can be used to 'raise the ability of oil palms and fruits to resist pests and diseases' received a mean score of 4.10. Here again, the opinion 'Agree' (66 persons, 39.5%) was most frequently selected by the respondents. 'Strongly agree' obtained the second-highest score, with 38.3% of the respondents (64 persons) holding this opinion. This was followed by those who were neutral (26 persons, 15.6%). Respondents who selected 'Disagree' numbered only eleven or 6.6%, while none declared they strongly disagreed. From this breakdown, it is clear that the respondents were of the view that technology could be used to raise the ability of oil palms and fruits to resist pests and diseases.

Table 2: Productivity component

Item	*Score frequency and percentage (%)					Mean	Level of importance
	1	2	3	4	5		
Application of modern technology eases work in palm oil production.	1 (0.6)	4 (2.4)	12 (7.2)	73 (43.7)	46.1 (77)	4.32	High
Raises quality and standard of palm oil.	2 (1.2)	4 (2.4)	23 (13.8)	71 (42.5)	69 (41.3)	4.21	High
Raises production of oil palm fruits consistently.	3 (1.8)	4 (2.4)	23 (13.8)	73 (43.7)	64 (38.3)	4.14	High
Raises the ability of oil palms and fruits to resist pests and diseases.	-	11 (6.6)	26 (15.6)	66 (39.5)	64 (38.3)	4.10	High
Facilitates the transportation of oil palm fruits to the factory for processing.	-	9 (5.4)	14 (18.4)	79 (47.3)	65 (38.9)	4.20	High
Raises the quality of oil palm planting materials.	2 (1.2)	6 (3.6)	25 (15.0)	63 (37.7)	71 (42.5)	4.17	High
Research and adoption of biotechnology produce quality planting materials.	2 (1.2)	4 (2.4)	17 (10.2)	83 (49.7)	61 (36.5)	4.18	High
Raises the weight of oil palm fruits and lessens the occurrence of loose fruits at the time of harvest.	-	7 (4.2)	19 (11.4)	78 (46.7)	63 (37.7)	4.18	High
Adoption of advanced technology results in the best outcome for planting that is consistently competitive.	1 (0.6)	6 (3.6)	17 (10.2)	67 (40.1)	76 (45.5)	4.26	High
Overall mean							4.20

*1- Strongly disagree, 2- Disagree, 3- Neutral, 4-Agree, 5- Strongly agree
n = 167; Source: Field study 2021

Regarding the fifth statement that technology can be harnessed to 'facilitate the transportation of oil palm fruits to the factory for processing', a mean score of 4.20 was attained. The response 'Agree' was again the most frequently selected, with 79 participants (47.3%) indicating their agreement with the statement. This was followed by the opinion 'Strongly agree' that had 65 respondents (38.9%) feeling that way. 'Neutral' and 'Disagree' garnered 8.4% and 5.4% respectively, with 14 and 9 persons expressing those opinions. The 'Strongly disagree' opinion was not held by any of the participants. The analysis here showed once again that the benefits of technology extended to the transportation of oil palm fruits to the factory for processing.

The sixth questionnaire statement suggests that technology 'raises the quality of oil palm planting materials'. The mean score attained for this statement was 4.17, with the largest segment of respondents (71 persons, 42.5%) offering a 'Strongly agree' opinion. The next popular opinion was 'Agree', which was held by 63 respondents (37.7%). Those

holding a neutral point of view were 25 participants (15.0%). The number professing 'Disagree' amounted to 3.6%, representing 6 respondents. Only one respondent (1.2%) held the view 'Strongly disagree'. From this analysis, the respondents as a whole believed that the quality of oil palm planting materials was indeed improved by technology.

The seventh statement, 'research and adoption of biotechnology produces quality planting materials,' had a mean score of 4.18. The opinion 'Agree' topped the selection of the respondents, with about half (82 persons, 49.7%) selecting this option. 'Strongly agree' came next, being the opinion of 61 respondents representing 36.4% of the study population. Those holding a neutral opinion and those who disagreed numbered 17 and four respectively, representing 10.2% and 2.4%. The viewpoint 'Strongly disagree' garnered 1.2% from two participants. It can be seen here that, among participants of the study sample, biotechnology was perceived as serving as an effective driver for the production of quality oil palm planting materials.

The eighth statement declared that technology could be used to 'raise the weight of oil palm fruits and lessen the occurrence of loose fruits at the time of harvest'. The mean score by the respondents was 4.18. A large proportion of the respondents (46.7% or 78 persons) opined 'Agree', while 37.7% (63 persons) selected 'Strongly agree'. The groups that were neutral or who chose 'Disagree' were numbered 19 and 7 persons respectively, making up 11.4% and 4.2% '. Here again, no respondent picked the option 'Strongly disagree'. What can be concluded is that modern technology such as formulated chemical fertilizers was believed to have contributed to fruit size. Moreover, the use of titanium knives lessened fruit drops from the brunches when cutting the fruit bunch during harvesting.

The final statement in the questionnaire can be seen as a rounding up of the role of technology in the productivity of oil palm. The statement posted to the respondents for their opinion was that 'adoption of advanced technology results in the best outcome for planting that is consistently competitive'. The mean score achieved was 4.26. Close to half of the participants (45.5%, 76 persons) ranked the statement 'Strongly agree'. Almost as many 40.1%, 67 persons) selected 'Agree'. Fewer rated the statement as 'Neutral' or 'Disagree', with the total amounting to 17 (10.2%) and 6 (3.6%) respectively. Only one respondent (0.6%) selected 'Strongly disagree'. The overview of the responses indicated that modern technology was considered a path towards significant development for the palm oil industry while it lessened the workload of oil palm farmers.

5. Discussion

From the 4.32 mean score of the questionnaire statement 'Application of modern technology eases oil palm production', it is obvious that modern technology and innovations go a long way to benefit oil palm smallholders. The gains come from savings of time and costs besides labor input which leads to heightened productivity. Planting and harvesting become more efficient and this leads to higher income. With this, comes an increase in the standard of living of the smallholders. Among the questionnaire statements, the lowest mean score attained was 4.10 which pertained to technology's ability to help oil palms and fruits resist pests and diseases. Nonetheless, this score was still relatively high and pointed to the relevance of technology in keeping the palms healthy, free of pests and diseases to raise productivity. There are many approaches to achieve this by using safe chemicals that do not endanger the environment. Overall, it can be concluded that modern technology and innovations have a positive effect on the livelihoods of oil palm smallholders by increasing productivity from the aspect of crop yield and labor input.

From the above analysis, several recommendations may be made with regard to the adoption of technology in oil palm growing. These suggestions would be forwarded to MPOB for implementation in their training programs so that smallholders can undertake their tasks more efficiently and systematically. This would be part of the MPOB's function in conveying recent findings and innovations to farmers to widen their knowledge in oil palm planting. Advancements in technology should lead to improvements in our daily lives and work activities. Workers in the agriculture sector would benefit greatly if innovations could lead to more efficient farming methods. Smallholders need to be properly trained in the operation and maintenance of machinery like tractors, harvesters, chemical injectors, etc. as well as the proper usage of agro-chemicals.

At this juncture, it is pertinent to point out that not many local folks are keen on working in the oil palm industry. The following proposal is to demonstrate the advantages of being involved in oil palm planting. This is especially relevant for youth in the Banting area where the shortage of field labor is often a problem and planters often have to pay high wages to foreign workers. While many youths do not think highly of working in oil palm planting, they should be aware that this is a major economic activity of the country that brings in a good income for the worker. Work in oil palm planting does not involve only manual labor, but good education is requisite among workers of this era because so many activities are now technology-based. There is demand for educated workers that would include new university graduates for whom this would be a good career choice.

6. Conclusion

It is clear from this study that modern technology has to have a foothold in the palm oil industry if it is to keep pace with advancements in the world. The human race is adept at innovations to facilitate and

enhance their well-being in their day-to-day activities. The palm oil sector is not lacking in this respect and there are many technologies that can be adapted to benefit the smallholder in different ways. It is up to the smallholder to take advantage of such new changes, and in this regard, TUNAS officers play an important role in organizing relevant courses to update growers so that they can take advantage of the opportunity to transform their smallholdings by harnessing modern technology.

The palm oil sector is crucial to the country's economy and is one that has seen continual development. Its progress has benefited from scientific research input over the years and the fruits of such research have been enjoyed by players in the industry through the transfer of technology. Oil palm planters in Banting have not been left out in this regard; they have received a positive impact from the application of technology and innovations as evidenced by increased efficiency and productivity. It is hoped that this study might serve as a reference that contributes to an understanding of how the application of modern technology can benefit the palm oil sector, as exemplified by smallholders in Banting, Selangor.

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Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

References

Ardana IK and Kariyasa K (2016). Pengaruh inovasi teknologi dan penggunaan input terhadap produktivitas kelapa sawit di provinsi kalimantan barat/influence of technological innovation and use of production input on productivity of oil palm in West Kalimantan province. Jurnal Penelitian Tanaman Industri, 22(3): 125-134. https://doi.org/10.21082/littri.v22n3.2016.125-134

Asnari AA and Wahid H (2018). Penglibatan pekebun kecil sawit dalam perniagaan dan keusahawanan: Kajian di teluk intan, perak. In the Conference of Persidangan Kebangsaan Ekonomi Malaysia ke-13, Universiti Kebangsaan Malaysia, Selangor, Malaysia.

Aurelie NN, Ejolle EE, Benedicte CP, and Jean-Claude B (2010). Assessment of training needs of rubber farmers in the South-west region of Cameroon. African Journal of Agricultural Research, 5(17): 2326-2331.

Azian FUM, Awang AH, Ibrahim I, Ramli Z, Lyndon N, Yusof I, and Abdul Hamid MH (2017). Kelestarian penanaman sawit dan produktiviti pekebun kecil persendirian. Journal Global Business and Social Entrepreneurship, 1(1): 12-20.

Aziz RA (1986). Pemindahan teknologi ke sektor desa: Antara pelaksanaan dan keberkesanan. Akademika Journal of Humanities and Social Sciences, 28: 3-19.

Azizan AA, Darawi Z, and Mamat MN (2012). Senario masa hadapan pasaran dan pemasaran industri minyak sawit malaysia ke arah perancangan strategik dalam peningkatan daya saing global. In the Persidangan Kebangsaan Ekonomi Malaysia Ke V2, Ipoh, Malaysia: 6-19.

Choy EA, Abdullah MA, and Zainol RM (2012). Kemampanan persekitaran klaster sawit: Kajian kes di sekitar Pulau Carey, Selangor. Geografia-Malaysia Journal of Society and Space, 8(8): 121-129.

Er AC and Siwar C (2015). Penanaman sawit lestari dan impak sosioekonomi. e-BANGI, 10: 57-80.

Er AC, Abdullah MA, and Zainol RM (2012). Kemampanan persekitaran klaster sawit: Kajian kes disekitar Pulau Carey, Selangor (Environmental sustainability of palm cluster: A case study in and around Carey Island, Selangor). Geografia, 8(8): 121-129.

Goh KC, Sim SY, Sam TH, Bilal K, Goh HH, and Mohamed S (2019). Integration precision and unmanned aerial vehicles technology in oil palm management system development. International Journal of Recent Technology and Engineering, 8(3s): 77-82. https://doi.org/10.35940/ijrte.C1015.1083S19

Hafizuddin-Syah BAM, Shahida S, and Fuad SH (2018). Sustainability certifications and financial profitability: An analysis on palm oil companies in Malaysia. Jurnal Pengurusan (UKM Journal of Management), 54: 143-154. https://doi.org/10.17576/pengurusan-2018-54-12

Hashim K, Mansor NH, Bakar HA, and Omar W (2014). Pusat TUNAS MPOB: Penggerak perubahan pekebun kecil sawit persendirian. Prosiding Persidangan Kebangsaan Pekebun Kecil Sawit, MPOB, Bangi, Malaysia: 207-218.

Khan ASMMR, Kabir MY, and Alam MM (2009). Variability, correlation path analysis of yield and yield components of pointed gourd. Journal of Agriculture and Rural Development, 7: 93-98. https://doi.org/10.3329/jard.v7i1.4427

Krejcie RV and Morgan DW (1970). Determining sample size for research activities. Educational and Psychological Measurement, 30(3): 607-610. https://doi.org/10.1177/001316447003000308

Mohd Nawi NS, Md Deros B, Nordin N, and Sukadarin EH (2018). Teknovasi dalam industri pertanian: Isu dan cabaran industri perladangan kelapa sawit. In the Seminar Kebangsaan Transformasi Sosio-Ekonomi Wilayah Utara (NCER) Ke-3, Ipoh, Malaysia: 183-191.

Othman MSS (2009). Penggunaan teknologi mekanikal (jentera) oleh petani-petani kaum etnik di kawasan siburan, Sarawak. Ph.D. Dissertation, Universiti Teknologi Malaysia, Johor Bahru, Malaysia.

Paramananthan S and Sen YH (2000). Soils of Malaysiatheir characteristics and identification (No. L-0807). S. Paramananthan, Kuala Lumpur, Malaysia.

Pemsl DE, Waibel H, and Witt R (2006). Diffusion of information among small-scale farmers in Senegal: The concept of farmer field schools. In the German Development Economics Conference, Berlin, Germany.

Peng TS, Lyndon N, and Hashim K (2020). Hubungan demografi terhadap tahap pengetahuan amalan baik pembajaan oleh pekebun kecil sawit di Malaysia. e-BANGI, 17(8): 224-238.

Rist L, Feintrenie L, and Levang P (2010). The livelihood impacts of oil palm: smallholders in Indonesia. Biodiversity and conservation, 19(4): 1009-1024. https://doi.org/10.1007/s10531-010-9815-z

Selvadurai S, Lyndon N, Ilelmi M, and Rahim A (2018). Economic problems faced by oil palm smallholders and its solution: The case of Malaysia. International Information Institute (Tokyo). Information, 21(6): 1789-1800.

Shuib AR, Khalid MR, and Deraman MS (2011). Innovation and technologies for oil palm mechanization. In: MPOB (Ed.), Further advances in oil palm research, 2000-2010: 569-597.

Volume 2, Malaysian Palm Oil Board, Ministry of Plantation Industries and Commodities, Bandar Baru Bangi, Malaysia.

Sowat SN, Ismail WIW, Mahadi MR, Bejo SK, and Kassim MSM (2018). Trend in the development of oil palm fruit harvesting technologies in Malaysia. Jurnal Teknologi, 80: 2. https://doi.org/10.11113/jt.v80.11298

Yusof I, Hashim K, Ramli Z, Lyndon N, Ibrahim I, Peng TS, and Hamid MHA (2016). Pemindahan teknologi dan produktiviti pekebun kecil persendirian sawit di Teluk Intan, Perak. e-BANGI, 11: 78-87.