Journal of Advanced Research in Applied Sciences and Engineering Technology

Journal homepage:
https://semarakilmu.com.my/journals/index.php/applied_sciences_eng_tech/index
ISSN: 2462-1943

Validity and Reliability of the Oil Palm Fertilizer Infographic Mobile App Module to Enhance Knowledge Practices in Palm Fertilization among Smallholders

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ARTICLE INFO

Article history:
Received 30 June 2024
Received in revised form 20 September 2024
Accepted 6 October 2024
Available online 30 November 2024

Keywords:
Validity; reliability; infographic; oil palm fertilizer; module

ABSTRACT

Implementing best practices in oil palm fertilisation is pivotal for enhancing fresh fruit bunch production within the oil palm cultivation sector. However, small-scale farmers in Malaysia still encounter a notable deficiency in understanding fertiliser management. Therefore, providing easily accessible and comprehensible sources of palm fertilisation information is crucial, with a focus on materials containing verified and dependable content from the Malaysian Palm Oil Board (MPOB). This study aims to evaluate the validity and reliability of the oil palm fertiliser infographic mobile app module for smallholders. The module's content was made simpler by referring to multiple documentation sources regarding recommended palm fertilisers by the Agronomic Unit of the MPOB. The infographic module is designed to encourage best practices in palm fertilisation for smallholders through a user-friendly mobile app platform. A module draft was submitted to five specialists in palm fertiliser and module development to assess its validity. Several improvements were made based on the comments and feedback gained from these experts. 55 individuals, including smallholders, contributed to evaluating the module's reliability and the impact of the knowledge practices in palm fertilisation. The entire module's content attained a validity rate of 90%, confirming the acceptance of its content validity. Furthermore, the module recorded a Cronbach's alpha value of 0.981, indicating a high level of reliability. The utilisation of this module within the mobile app platform suggests that the application could effectively improve users' knowledge of palm oil fertilisation practices. These findings demonstrated that the Infographic Oil Palm Fertilizer is appropriate and successful in achieving the intended learning objectives.

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https://doi.org/10.37934/araset.53.2.3747

1. Introduction

Elderly smallholders in oil palm industries are keen to cultivate high-quality oil palms, ultimately boosting the nation's palm oil sector. Sharing their knowledge and skills on palm oil fertilisation with the younger generation can help sustain this noble cause for the future. Generally, knowledge of oil palm cultivation is acquired through informal channels, such as casual discussions or education provided by specific oil palm agencies. Therefore, the primary purpose of developing an Infographic Oil Palm Fertilizer module is to provide smallholders with valuable information on palm oil fertilisation. Due to its digital format, the module is made more realistic, practical, and accessible, and it can be accessed online using a mobile application.

The Infographic Oil Palm Fertilizer module is expected to disseminate information on good practices in palm fertilization for oil palm smallholders in Malaysia. This will provide significant support to the TUNAS - Tunjuk Ajar Sawit (Palm Oil Guidance and Advice) training center of the Malaysian Palm Oil Board (MPOB), improving the hands-on guidance on palm oil fertilization for smallholders. Its objective is to back the progress of small, inexperienced oil palm smallholders within the younger demographic, as most oil palm agencies and smallholder apprentices in Malaysia are youthful. As a result, further studies on developing high-quality fertiliser modules are deemed necessary, given their importance in aiding small oil palm holders with knowledge about fertilisation [1]. Thus, it is essential to assess the content validity and reliability of the module to guarantee that the developed learning material is trustworthy and efficient in meeting the established learning goals. Therefore, the key goal of this investigation is to verify the content validity and reliability of the Infographic Oil Palm Fertilizer module and analyse how perceived knowledge of palm fertilisation practices impacts smallholder users.

1.1 Literature Review

The deficiency in fertiliser management knowledge has been identified as a significant factor contributing to the low production of fresh fruit bunches (Buah Tandan Segar, BTS) among oil palm smallholders in Malaysia [2]. Thus, it is crucial to implement best management practices to enhance fertilisation works' efficiency [3]. In line with that, the MPOB established the TUNAS Centre at the end of 2002 to provide advisory services to smallholders [4]. The centre is responsible for conveying information on oil palm fertilisation through supporting media, such as Warta Sawit and Risalah Sawit [5]. This information typically comprises formal articles with textual elements supported by tables, diagrams, pictures, and graphics.

Hence, the Oil Palm Fertilizer Module was devised as a Malay-language infographic, offering thorough guidance on fundamental principles governing effective oil palm fertilisation practices. This module functions as an essential resource, with a focus on supporting inexperienced smallholders and helping them engage effectively in the palm oil cultivation sector. Given the complex and knowledge-intensive nature of the domain, it is presumed that novice users benefit significantly from enhanced guidance and experiential learning opportunities [6]. Therefore, all reference materials for oil palm fertilisation, whether printed or online, must be tailored to their cognitive ability for better comprehension and understanding. In line with the Principles of Cognitive Load Theory, the Oil Palm Fertilizer application has been specifically designed to align with the cognitive abilities of novice users. All modules in the application use infographics that combine graphic and visual elements with concise, appealing, and easily understandable text to present information. In addition, presenting infographic information that allows difficult information to be processed in simple form [7] is one of the most effective strategies for helping and improving the learning process. This is because

infographics use simple sentences and images that make it easy to read and provide an interesting visual summary [8].

In addition, given that the Oil Palm Fertilizer Module aims to educate novices about oil palm fertilisation, evaluating its validity and reliability is crucial to guarantee high-quality standards. Assessing validity involves determining how effectively a module captures its intended elements, while reliability examines the consistency of the module's outcomes. Validating and ensuring reliability are both essential when assessing the quality of a module in different educational environments to meet the established learning goals [9,10].

2. Methodology

This study employed a descriptive research design to evaluate the validity and reliability of the Infographic Oil Palm Fertilizer module. Additionally, a one-group pre-test and post-test experimental method were utilised to discern the impact of the module on users' perceived knowledge practices in palm fertilisation. This approach allowed for a comprehensive assessment of users' perceptions before and after exposure to the module, thereby facilitating an analysis of its effectiveness in enhancing their understanding and application of palm fertilisation practices. The content validity of the module was evaluated by five MPOB experts in agronomy and palm cultivation, with a particular focus on palm fertilisation [11]. The selection of this MPOB expert is due to the need for fertilization information in this module to align with the standard and validated fertilization practices for all smallholders. This ensures compliance with the information stipulations from the MPOB, the body responsible for planning, researching, and developing the palm oil industry in Malaysia, which operates under the Ministry of Plantation Industries and Commodities, Malaysia. Table 1 presents the profiles of these content experts. Furthermore, Cronbach's alpha internal validity coefficient was used to assess the module's content validity and reliability coefficient.

Table 1
Profiles of the expert validity panels

No.	Profile	Institution	Area of expertise
1.	Head of agronomy unit	MPOB	Agronomy
2.	Agronomy officer	MPOB	Agronomy
3.	Head of smallholder unit MPOB oil palm Plantation	MPOB	Oil palm plantation
4.	Agronomy researcher	MPOB	Agronomy
5.	Agronomy officer	MPOB	Agronomy

All appointed experts were given a detailed version of the Infographic Oil Palm Fertilizer module, along with copies of the content validity questionnaire and appointment letter. All data obtained were analysed descriptively using the percentage validity values of the module's content. The content validity assessment followed the guidelines outlined by Kaplan and Saccuzzo [12]. An indication of high validity is given by scores that are 70% or higher, whereas scores under 70% suggest low content validity. Additionally, the experts shared their opinions and provided comments to improve the module's content.

A workshop was conducted at MPOB to assess the module's reliability and knowledge practices in palm fertilisation using the Infographic Oil Palm Fertilizer mobile application, involving 55 small oil palm smallholders. The selection of smallholder zone was carried out by MPOB, and field officers intentionally chose these smallholders from their respective zones which are the Central Zone and the Southern Zone located near the MPOB HQ office. The purposive sampling method was used in

this study to gather information from a specific group of samples that represent the entire smallholder population. Before starting the session, they need to fill out the pre-test questionnaire on knowledge practices in palm fertilisation. Then, they were given instructions on how to use the application, after which they had the chance to explore information on oil palm fertilisation independently using the oil palm fertiliser application. The mobile application will serve as a mobile platform that can be accessed via a smartphone by all Malaysian oil palm smallholders. The development process uses the Mobile Application Development Live Cycle (MADLC) model, which comprises seven phases: Identification, design, development, prototype, testing, deployment, and maintenance, as shown in Figure 1.

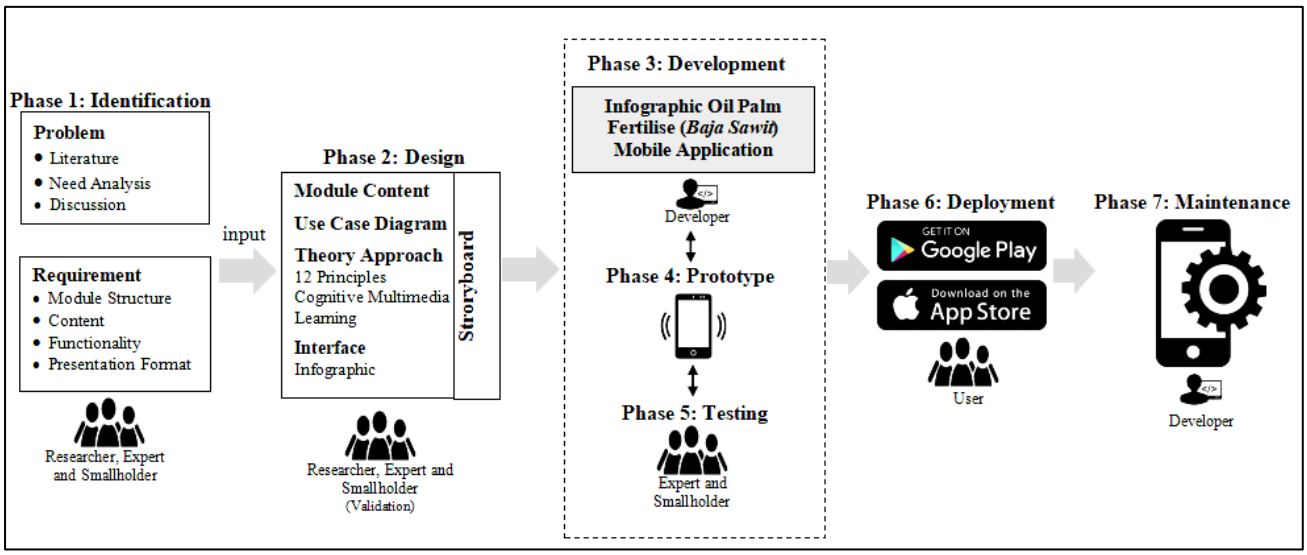

Fig. 1. Oil palm fertilize infographic mobile app development cycle

Figure 2 depicts the interface for the main menu in the Infographic Baja Sawit Mobile Application, along with interfaces for each of the components for palm fertilisation: Fertilization Concept (*Asas Pembajaan*), Get to Know Palm Fertilizer (*Kenali Baja Sawit*), Nutrient Deficiency Symptoms (*Tanda Kekurangan Nutrien*), Oil Palm Fertilizer Types (*Jenis Baja Sawit*), Fertilization Methods (*Kaedah Pembajaan*), and Fertilizer Formulations (*Formulasi Baja*). Each module consists of a sub-module, as specified in the design phase.

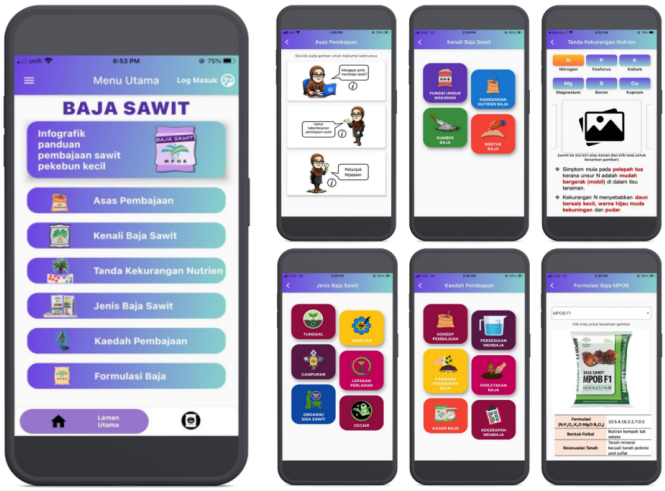

Fig. 2. The component and the module of the palm fertilisation information interface

In the final stage of the workshop, all smallholders filled out a questionnaire to assess the module's reliability and a post-test questionnaire on knowledge practices in palm fertilisation. The data was later analysed using SPSS software to derive Cronbach's alpha coefficient values to measure reliability. According to Kaplan and Saccuzzo [12], reliability coefficients between 0.7 and 0.8 are considered acceptable. The data was also analysed using a paired t-test to identify the significance difference in knowledge practices in palm fertilisation between before and after using the Oil Palm Fertilizer Infographic Mobile App module.

2.1 Instrument

The accuracy of module content pertains to how well the concepts and information in a module [13] match the requirements of the intended users. In this study, it was essential to ensure that the module's information on oil palm fertilisers precisely met the needs of its intended users: the oil palm smallholders who depend on this guidance for effective fertilisation practices. The measurement of content validity was conducted using a questionnaire modified by Sidek and Jamaludin [10], adapted from Russell [14]. It outlined the standards for a module containing quality content, such as its congruence with the intended audience, relevance to instructional settings, proper timing, enhancement of performance, and capacity for influencing attitudes. In accordance with this reference, the questionnaire was structured to encompass five key items to evaluate various aspects of the module's efficacy. These items examined the relevance of the content for the target population, the practicality of implementing the module, its suitability within the given timeframe, its potential to enhance fertilisation practices, and its efficacy in imparting knowledge on fertilisation practice. The questionnaire utilised a five-point Likert scale, ranging from (5) Strongly Agree to (1) Strongly Disagree.

The content validity questionnaire was also applied to each sub-module using the format presented by Mohamad Aziz Shah [15]. The central module comprises six parts: fertilisation idea, familiarisation with palm fertiliser, signs of nutrient deficiency, kinds of palm fertiliser, fertilisation techniques, and MPOB fertiliser composition. Each component was developed based on the corresponding sub-module information. The response options utilised a semantic scale ranging from 1 (Strongly Disagree) to 5 (Strongly Agree). To determine the content validity level, the expert's score (x) was divided by the total actual score (y) and multiplied by one hundred. A module attains high content validity when it scores 70% or higher, indicating a substantial level of achievement [8]. The validity formula is as follows:

$$\frac{Total\ Expert\ Score\ (x)}{Total\ Actual\ Score\ (y)} \times 100\% = Content\ Validity\ Achievement \quad [1]$$

Module reliability refers to the consistency and stability of a module in achieving its intended objectives [15]. The items utilised to evaluate the dependability of the Oil Palm Fertilizer module in this research were developed based on the goals specified for each task in the module, adhering to the recommendations proposed by Fuad *et al.,* [9]. These items were selected to match the intended achievements and goals of the smallholders. The aim was for them to understand and accomplish the objectives laid out in the module. The questionnaire utilised a five-point Likert scale, ranging from (5) Strongly Agree to (1) Strongly Disagree. The Cronbach's alpha coefficient was employed to assess the reliability of the questionnaire. According to Mohd Majid [16], a reliability value of at least 0.60 indicates good consistency in the Oil Palm Fertilizer application module. Likewise, a reliability value that falls below 0.60 suggests a poor level of consistency in the module, indicating a need for improvement.

Finally, the study utilised a questionnaire developed by Peng *et al.,* [5] to assess the understanding of effective fertilisation methods among oil palm smallholders. This questionnaire of 20 items has been refined and verified by experts from the Smallholder Extension and Certification Division unit, Malaysian Palm Oil Board (MPOB).

3. Results

3.1 Validity of Overall Module Content

A panel of experts evaluated the content validity of the Oil Palm Fertilizer module using a modified questionnaire from Arip [15]. Table 2 shows the expert's evaluation results where the module's content achieved a minimum percentage of 86%, which aligned with the allocated time. The item "The content of this Oil Palm Fertilizer module meets the target population of palm oil smallholders" obtained the highest percentage of 94%. Overall, the entire content of the Oil Palm Fertilizer module exceeded the minimum threshold of 70%, showcasing high content validity and thorough validation.

Table 2
Validity of oil palm fertilizer module content

No.	Item	Percentage	Expert view
1.	The content of this Oil Palm Fertilizer module meets the target population of palm oil smallholders.	94	Accepted
2.	The content of this Oil Palm Fertilizer module can be implemented perfectly.	89	Accepted
3.	The content of this Oil Palm Fertilizer module corresponds to the allotted time.	86	Accepted
4.	The content of this Oil Palm Fertilizer module can improve the knowledge of good fertilisation practices among palm oil smallholders.	93	Accepted
5.	The content of this Oil Palm Fertilizer module can help provide a simple guide to good fertilisation practices among palm oil smallholders.	89	Accepted

3.2 Validity of Sub-Module Content

The experts also evaluated the content validity of the sub-modules, and the results are presented in Table 3. The overall content validity was 90%, surpassing the minimum threshold of 70%. Further validity analysis by main module category revealed that the Types of Palm Fertilizer module obtained the lowest percentage of 88% while the Fertilization Method module obtained the highest percentage of 92%. Similarly, in the sub-module analysis, Info Liquid scored the lowest percentage at 82%, while Fertilizer Requirements and all sub-modules under the Fertilization Method achieved the highest percentage of 92%. In general, the experts' evaluation of each main module and sub-module category confirmed that the Palm Fertilizer module exhibited high and good content validity, with a consensus value exceeding the minimum threshold of 70%.

Table 4 presents the experts' comments regarding the module content for further improvement. The revision and refinement of the module took into account all comments and feedback received. Overall, the experts' comments and feedback suggested that the Oil Palm Fertilizer Application module was successfully aligned with the stated objectives.

Table 3
Validity of oil palm fertilizer sub-module content

Main module	Sub-module	Percentage	Expert view
Fertilisation concept	Info 1: Fertiliser requirements	92	Accepted
	Info 2: Fertiliser factor	91	Accepted
	Info 3: Success indicator	90	Accepted
		91	
Get to know palm fertilizer	Info 1: Function of food elements	89	Accepted
	Info 2: Compound fertiliser nutrient	90	Accepted
	content	90	Accepted
	Info 3: Fertiliser source	90	Accepted
	Info 4: Fertiliser form	**90**	
Nutrient deficiency symptom	Info 1: N	90	Accepted
	Info 2: P	90	Accepted
	Info 3: K	90	Accepted
	Info 4: Mg	90	Accepted
	Info 5: B	90	Accepted
	Info 6: Cu	90	Accepted
		90	.
Types of palm fertilizer	Info 1: Single	90	Accepted
	Info 2: Compound	90	Accepted
	Info 3: Mixed	90	Accepted
	Info 4: Slow release	90	Accepted
	Info 5: Organic/palm waste	88	Accepted
	Info 6: Liquid	82	Accepted
		88	
Fertilisation method	Info 1: Concept of fertilization	92	Accepted
	Info 2: Fertilising preparation	92	Accepted
	Info 3: Fertilizer spreading	92	Accepted
	Info 4: Placement of fertilizer	92	Accepted
	Info 5: Fertiliser rate guide	92	Accepted
	Info 6: Fertiliser frequency	92	Accepted
		92	
MPOB fertilizer formulation		88	Accepted
Overall		90	Accepted

Table 4
Feedback on the content of the oil palm fertilizer module

Expert	Feedback
Expert 1	i. Pictures related to examples of fertiliser calibration gauges and signs of N deficiency.
	ii. Video examples of manual and mechanical sowing.
	iii. The whole module is good.
Expert 2	i. Spelling correction: Page 13 - season.
	ii. Spelling correction: Page 63 - ROOT, EFFICIENT.
	iii. Formula correction: Page 101-114 - CuSO4 and ZnSO4 (4 must be subscripted).
	iv. The module is very helpful but depends on the commitment of the smallholder.
	v. The module is very relevant as a reference.
	vi. The use of modules depends on the commitment of smallholders.
	vii. The module is very helpful but depends on the commitment of the smallholder.
	viii. The module is very relevant as a reference.
Expert 3	i. The success factors of oil palm fertilisation have been stated, namely the type, rate, time and location. It may be possible to add the most suitable method of fertilisation because PK is used to plant fertiliser in the soil.
	ii. It is necessary to explain the appropriate method of fertilising in hilly/terraced/platform areas.

Table 4. Continued
Feedback on the content of the oil palm fertilizer module

Expert	Feedback
	iii. Records of loose fertilisers by smallholders need to be clearly stated. Fertilising frequency/year, fertilising rate/rotation, amount of fertiliser used, and fertiliser cost.
	iv. Pictures of each nutrient's deficiency symptoms must clearly show whether the tree is young or mature.
	v. Symptoms of nutrient deficiency of oil palm grown in peat areas.
	vi. Symptoms of N and K fertiliser imbalance need to be shown (N/K nutrient imbalance).
	vii. Also, get information about oil palm production (mt/month) and BTS price obtained.
	viii. Some minor amendments for consideration.
	ix. The entire module is adequate.
Expert 4	i. Fertilising requirements and fertiliser factors with fertilising effectiveness replace fertiliser requirements.
	ii. Compound fertiliser content, N-maintain; K to K2O, P to P2O5, Mg to MgO, B to B2O3.
Expert 5	i. The whole module is good and useful for smallholders.

3.3 Module's reliability

Tables 5 and 6 present the module's reliability results determined through the Oil Palm Fertilizer application session with palm oil smallholders. The module's overall reliability recorded a Cronbach's alpha value of 0.981, significantly higher than the 0.60 threshold. The highest value of 0.980 was observed for the MPOB Fertilizer Formulation main module, while the lowest value of 0.818 was obtained by the sub-module "Info 3: Indicators of Success" within the Fertilizer Concept main module. These findings indicated that the Palm Fertilizer application module demonstrated high reliability and could be effectively utilised to enhance the knowledge of good fertilisation practices among oil palm smallholders. In other words, the module provides concise guidance on adopting these good practices.

Table 5
Reliability of the oil palm fertilizer application module

Module	Cronbach's alpha (α)
Oil palm fertilizer application module	0.981

Table 6
Module reliability value and oil palm fertilizer sub-module

Main module	Sub-module	Cronbach's alpha (α)
Fertilisation concept	Info 1: Fertiliser requirements	0.886
	Info 2: Fertiliser factor	0.836
	Info 3: Success indicator	0.818
Get to know palm fertilizer	Info 1: Function of food elements	0.844
	Info 2: Compound fertiliser nutrient content	0.887
	Info 3: Fertiliser source	0.872
	Info 4: Fertiliser form	0.875
Nutrient deficiency symptom	Info 1: N	0.964
	Info 2: P	0.922
	Info 3: K	0.925
	Info 4: Mg	0.915
	Info 5: B	0.918
	Info 6: Cu	0.925
Types of palm fertilizer	Info 1: Single	0.968
	Info 2: Compound	0.966
	Info 3: Mixed	0.964

Table 6
Module reliability value and oil palm fertilizer sub-module

Main module	Sub-module	Cronbach's alpha (α)
	Info 4: Slow release	0.966
	Info 5: Organic/palm waste	0.965
	Info 6: Liquid	0.965
Fertilisation method	Info 1: Concept of fertilization	0.894
	Info 2: Fertilising preparation	0.944
	Info 3: Fertilizer spreading	0.922
	Info 4: Placement of fertilizer	0.921
	Info 5: Fertiliser rate guide	0.941
	Info 6: Fertiliser frequency	0.931
MPOB fertilizer formulation		0.980

3.4 Palm Fertilization Knowledge Practices

The comparison of palm fertilisation knowledge practices collected before and after using the Oil Palm Fertilizer Infographic Mobile App throughout the training course was analysed using a paired t-test. The results indicate a notable disparity in data analysis regarding Palm Fertilization Knowledge Practices pre- and post-utilisation of the Oil Palm Fertilizer Infographic Mobile App ($t = 4.395$, $df = 54$, $p < 0.05$). Table 7 demonstrates that the perception of palm fertilisation knowledge practices after using Oil Palm Fertilizer Infographic Mobile App ($M = 4.31$, $SD = 0.94$) outperforms the result before using Oil Palm Fertilizer Infographic Mobile App ($M = 3.88$, $SD = 0.99$). Based on the findings, it can be concluded that using the Oil Palm Fertilizer Infographic Mobile App could improve the users' Palm Fertilization Knowledge Practices as the module design considers expert validity and reliability. The Oil Palm Fertilizer Infographic Mobile App module is easy to understand. Infographic presentations successfully engage users, creating a genuine learning opportunity that encourages the exploration and understanding of palm fertilisation practices using the Oil Palm Fertilizer Infographic Mobile App.

Table 7
Palm fertilization knowledge practices before and after using oil palm fertilizer infographic mobile app

Palm fertilization knowledge practices	N	Mean	Standard deviation	t-value	df	P
Before	55	3.88	0.99	4.395	54	0.000
After	55	4.31	0.94			

4. Conclusions

The content of the Infographic Oil Palm Fertilizer module was derived from the fundamental principles of palm fertilisation practices established by MPOB. It comprises six main modules: Fertilization Concepts, Recognising Oil Palm Fertilizer, Nutrient Deficiency Symptom, Types of Oil Palm Fertilizer, Fertilization Methods, and MPOB Fertilizer Formulation. The module highlights the significance of adhering to good practice procedures for oil palm fertilisation. Therefore, developing a good module is imperative to ensure it genuinely benefits the target users. Its validity and reliability are equally important to guarantee that the learning module is practical and will benefit the intended users. Our results showed that the Infographic Oil Palm Fertilizer module and its main modules and sub-modules exhibited high content validity. This finding is consistent with previous studies by Nur Liyana *et al.,* [17], Jasmi *et al.,* [18], Amla *et al.,* [19], Lau *et al.,* [20], and Mahmud *et al.,* [21], which employed similar content validity testing procedure. At the same time, verifying the module's

reliability affirmed its efficacy in reaching the defined learning objectives and was regarded as satisfactory and acceptable [22].

In conclusion, this study found that the Infographic Oil Palm Fertilizer module had significantly high content validity and reliability. The Oil Palm Fertiliser Infographic Mobile App module is a valuable resource for smallholders, aiming to provide essential information and knowledge about the best practices for oil palm fertiliser. Moreover, mobile app platforms designed to run on mobile devices such as smartphones, tablets, or touchscreen devices [23] enable worldwide access to information anytime, anywhere via the Internet, increasing the mobility of knowledge [24]. Additionally, this module intends to offer support and guidance through the TUNAS center, enabling smallholders to learn hands-on oil palm fertilisation techniques. Hence, the module provides infographic information on oil palm fertiliser, benefiting not only oil palm smallholders and stakeholders but also the MPOB training unit (TUNAS) and the broader oil palm industry in Malaysia. Smallholders have shown positive feedback towards the Oil Palm Fertiliser Infographic Mobile App Module. However, there is still a need for further improvements in various aspects to enhance the module's impact and expand its reach. One of these initiatives is a community outreach programme that offers focused workshops and practical training. One option is to produce a collection of podcasts or radio programmes that focus on agricultural best practices, success stories, and interviews with experts. These can then be aired on local radio stations or made available for download. Finally, the informative short video could emphasise technique and practice, making it suitable for sharing on social media or distributing offline through DVDs.

Acknowledgement
The authors extend their sincere gratitude to the MPOB-UKM Endowment Chair at Universiti Kebangsaan Malaysia for providing the opportunity and grant (MPOB-UKM-2021-004) for this project, as well as for the valuable collaboration and contribution from the Malaysian Palm Oil Board (MPOB).

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