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Farmers' Local Knowledge in Accelerating Banana Fruiting to Increase Production Quality and Economic Benefit: A Case in Pragaan, Sumenep Regency, Indonesia

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Abstract | Farmers' local knowledge is often related to practices that help improve cultivation technology towards sustainable agriculture. Therefore, the conservation and sustainability of farmers' local knowledge on the acceleration of banana fruiting is essential. This study explores the practices carried out by farmers to accelerate banana fruiting, improve the quality of banana yields, and the economic benefits that farmers can obtain. The qualitative research used an interpretative approach, conducted through in-depth interviews with 17 farmer participants who accelerated banana fruiting. In addition, direct observation in the field was carried out to explore farmers' knowledge and crosscheck interview results to increase research credibility. The results showed that farmers have local knowledge of suckers cutting, flower petal peeling techniques, and cutting banana hearts to accelerate banana fruiting and improve the quality of banana yields. Applying this local knowledge led to economic benefits from selling sucker-cut seeds and increased prices due to the enhanced quality of bananas produced. Policy makers can use this local knowledge to develop innovations in banana cultivation to support food supply and economic growth in the agricultural sector for other regions, especially in the context of banana plants.

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Introduction

Community interaction with the environment to meet their needs creates valuable local knowledge for community survival (Mane Kandari *et al.*, 2017). This local knowledge is the main asset in the community's struggle to get food, produce, and generate income. The process depends on the potential of natural resources and is influenced by local communities' attitudes, views, and behavior (Iniesta-Arandia *et*

al., 2014; Prasetyo *et al.*, 2022a). For example, on dry land in Timor, local farmers' knowledge about planting patterns was formed to respond to local dry climate conditions (Dimu-Heo *et al.*, 2022). Likewise, there is local knowledge of farmers about the services of beneficial insects and birds providing ecosystem services in agroecosystems (Hadinoto *et al.*, 2023; Rawluk and Saunders, 2019). Other studies report that local knowledge of agricultural systems emerged as a response to forest ecosystems (Murhaini and Achmadi, 2021). Several researchers also reported local knowledge to maintain the continuity of agroecosystems (Murhaini and Achmadi, 2021; Noble *et al.*, 2020; Putri *et al.*, 2019; Shepherd, 2010; Widodo *et al.*, 2023). Applying this local knowledge will prevent environmental damage and its consequences so that humans can live in harmony with nature and the continuity of future generations is protected (Damat, *et al.*, 2024; Schwann, 2018; Wicaksono *et al.*, 2022).

Other research results report that secondary forest management requires local knowledge of butterfly services that provide ecosystem services (Cuevas-Mendieta *et al.*, 2021). Meanwhile, it was also reported that local community knowledge can be used as a basis for ecological urban landscape planning and as a basis for evaluation (Fu *et al.*, 2016).

However, with the development of various land and environmental resource uses, local ecological knowledge could be threatened with extinction (Boilat and Berkes, 2013; Prasetyo *et al.*, 2022b). The same was reported by Endayani (2023) the increasingly rapid development of the times has tremendously impacted changes in people's behavior. Even though much local wisdom is starting to disappear, some local wisdom still survives and is held tightly by farmers in their agricultural activities. Local knowledge that farmers still apply needs to be identified and preserved (Wibowo *et al.*, 2021), including local knowledge of banana farmers accelerating banana fertilization in Sumenep Regency, Indonesia. This local knowledge can be used to prepare technical instructions for banana cultivation. It can be disseminated to farmers in banana production centers to benefit from time, quality improvement, and income from their farming business.

This research aims to describe farmers' local knowledge, analyze the effect of farmers' local knowledge in accelerating banana fruiting on the quality of the harvest, and analyze the economic benefits of applying local wisdom.

Materials and Methods

Research location

The study was conducted in Pragaan District, Sumenep Regency. Indonesia. This location is located at 7.119159 S to 113.621647 E (Figure 1). Sumenep is one of the banana-producing districts in East Java Province, Indonesia. Many banana farmers apply specific methods to accelerate banana fruiting in this area.

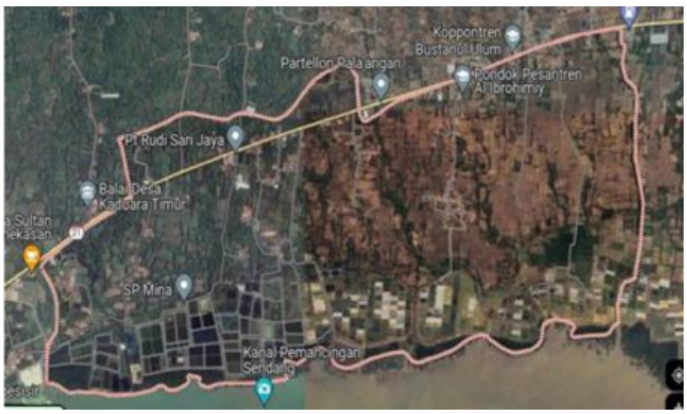

Figure 1: *Research location map.*

Research type and paradigm

A qualitative approach was used in this research, in which the researchers constructed the reality found. The paradigm used is the interpretative paradigm. To describe the local knowledge of banana farmers, researchers and participants explored this to obtain findings by conducting interviews and observations and analyzing them. Farmers' knowledge is formed based on experience (Goulet, 2013), namely the experience of farmers cultivating bananas in the research area. Therefore, interview and observation methods are appropriate for exploring farmers' knowledge in accelerating banana fruiting. Observations were carried out by observing how farmers reduce suckers, cut suckers, choose suckers that have been cut as replacements for the mother plant, peel flower petals, and cut banana blossoms.

Role of the researcher

To gain an in-depth understanding of farmers' local knowledge, the researcher began the research by taking the role of observer, interviewer, and active participant in accelerating banana fruiting in the field. As an observer, it allows researchers to feel and ex-

perience directly how farmers apply local knowledge. Meanwhile, the researcher's role as an interviewer is to obtain an in-depth participant perspective. Therefore, the questions asked of participants were open questions so that they could explore more in-depth information. The researcher also participated actively in the farmers' daily activities to gain trust and directly observe the practice of accelerating banana fruiting. The possibility of bias in the analysis and to increase the credibility of the research, the researcher reflects on his role in this research, namely building awareness that his background, experience, and perspective can influence the interpretation of the data. Apart from that, triangulation activities were also carried out to increase the credibility of the research.

Participants

Participants in this research were banana farmers who had experienced accelerating banana fruiting. The researchers chose 17 participants based on the key informant's recommendation. These farmers have intensively applied this local wisdom and have been applying it for many years. All participants are willing to be actively involved in research activities such as in-depth interviews, discussions, and observing the acceleration of banana fruiting. Participants are given symbols P1 to P17. The language used in interviews was simplified based on the understanding of informants who were low-educated farmers.

Data collection

Data was collected through interviews with farmers who had experience applying accelerated banana fruiting and observation techniques. An open interview method was used in this study, in which interviews were recorded and transcribed. In addition, field notes were written directly by researchers on location. The observation method was used to get initial data and see firsthand how farmers accelerate banana fruiting. In addition, observations were carried out to confirm and deepen the information obtained through interviews.

Data analysis

The process of analyzing the data that has been obtained refers to Miles and Huberman (Miles *et al.*, 2016). The data analysis begins after the first interview and lasts until the data saturation point is reached. The stages of data analysis include the coding process, categorization, determining themes, and the process of forming propositions. The analysis process is not carried out sequentially but is carried out iteratively (Morgan and Nica, 2020). The process can be repeated and returned to the previous stage according to the latest data requirements.

Coding was carried out immediately after the data was obtained, and a verbatim transcript of the interview results was made. The data that has been collected has been read, and the reading has been done more than twice. Then, reflection was carried out, connecting the participants' answers with the research questions. Code generation was repeated and then grouped according to the research objectives. The themes that emerged from this research data were generated through thematic analysis (Braun and Clarke, 2019). Interpretation of the findings refers to the research objectives and is supported by research literature related to local knowledge of accelerated banana fruiting.

To maintain the validity and reliability of the research, triangulation techniques of sources and methods were carried out (Donkoh and Mensah, 2023).

Results and Discussion

Banana plants have a significant contribution to the economy of people, especially those in rural areas, most of whom earn their living as farmers, although this is not their primary source of income (Ronner *et al.*, 2023; Zulfikar *et al.*, 2021). Some farmers even cultivate bananas intensively using a monoculture system as a source of income for farmers. The monoculture system was chosen because it is easier to maintain and has more significant income opportunities than other crops, so many farmers work intensively to obtain abundant and high-quality harvests (Hong *et al.*, 2020). Likewise, more farmers in the research location choose a monoculture system.

Farmers' knowledge about accelerating banana fruiting

Farmers have farming knowledge from experience interacting with their environment. When farmers did maintenance tasks on banana trees grown in a monoculture system, they unintentionally learned about rapid banana fruiting. The intention is to reduce the banana seedlings that grow so that they are not too dense and disturb the mother stem during fertilization and that there is no competition for nutrients. It turned out that after observing the stem, the prominent banana had increased in volume, and the stem

became stronger so that it was not easily knocked over by the wind and supported the fruit. Suckers that are cut grow faster than those that are not cut, and their growth is better so that they can be used as successors to the mother plant, as expressed by the first participant (P1) and reinforced by P5's statement.

"*Suckers that grow on the mother banana must be reduced and pruned so as not to interfere with the growth and fertilization process of the mother banana and only leave 1 to 2 suckers.*"

Reducing banana suckers is commonly done by many farmers, but some farmers try to prune several of the remaining suckers. Then, let it grow until it bears fruit, and observe the fruiting time until it is noted that pruning the suckers can speed up fruiting. This was said by the first informant (P1) as follows.

"*Suckers that are always cut as successors will bear fruit more quickly than those that are not cut because they grow faster*"

Farmers also prune the banana blossoms and peel the banana flower petals to get better quality fruit.

"*To speed up the ripening of the fruit and at the same time ensure it has good quality, the banana heart must be pruned before it curves downwards and the flower petals on the comb must be peeled off" (P1 and P2)*"

The advantage and benefit of suckers that are often cut (pruned) is that their height only reaches 3 m to 4 m, whereas suckers that are never cut can reach 5 m, meaning that the suckers that have been cut are already old at the bottom (old tubers). Another advantage of cutting suckers is that bananas will bear fruit more quickly than suckers that have never been cut. Suckers that have never been cut will flower when they are 8 mo old, whereas, with the cutting technique at 6 mo to 7 mo, the bananas will start to flower, so the age difference is between 1 mo and 2 mo.

"*The advantage of pruning or cutting off the suckers is that the bananas will bear fruit quickly and two months faster than those without cutting off the suckers.*" (P12).

It is necessary to cut off the suckers because it will affect the fruit and the number of combs in the bunch. If in one clump (mother) several growing suckers are not cut at all, then the number of fruit combs will decrease, and the density and diameter of the fruit will also not be so large, even the wrinkles will not be densely filled so it will affect the selling price. Suckers that are never cut will experience a degradation in the number of fruit combs, namely only producing five combs to seven combs, whereas if one bunch is cut regularly, one can produce (10 to 18) combs with densely packed fruit. Reducing suckers in banana clusters affects banana fruit production because it will suppress photosynthate competition for fruit bunches' growth with tillers' development (Dorel *et al.*, 2016).

By using the cutting technique, farmers obtain many benefits or profits in terms of time, speed of fruiting, sale of seeds, and return on capital. The advantage of time is that the bananas will bear fruit quickly because the suckers are already mature beneath (old tubers) of the parent, which is caused by regular cutting. In contrast, from an economic perspective, the suckers that have been cut can be used as planting material and sold to other farmers. Most buyers (farmers) will choose suckers that have been cut, even though they have to wait several weeks because cut suckers are not immediately available in the garden, so you have to order them in advance so you can get good quality, healthy, and fertile suckers.

With intensive maintenance, one cluster can be harvested three times a year in 4 mo. In contrast, with regular maintenance, the average banana can only be harvested two times a year, depending on the farmer's motivation (enthusiasm) to increase income. According to the farmers, the money from selling bananas does not run out until the harvest in the following month for four months because the income earned is significant, even though it has been spent on family needs. Banana cultivation is a farming business with excellent prospects for development because demand is constantly increasing, both from public consumers and the agroindustry; this is related to the increase in population, which is growing yearly. Therefore, improving the growth of banana production is very important to meet consumer needs (Petsakos *et al.*, 2019).

Other farmers noticed P1's success and tried to ask how bananas produce long fruit bunches with many combs and large fruit sizes. Finally, there was accelerated dissemination of banana fruiting between farmers. Farmers share their knowledge with other farm-

ers and discuss ways to improve banana cultivation practices. This can happen through direct face-to-face interaction (Thomas *et al*., 2020). Finally, the number of farmers who cut suckers to accelerate fruiting and produce good-quality fruit is growing. Currently, most farmers use the sucker-cutting technique because it has many advantages and benefits regarding the economy and time.

This local knowledge needs to be developed and disseminated so that farmers have adequate expertise in developing agriculture (Mariani and Usmeldi, 2019). These two types of farmer knowledge are technically explained as follows:

Sucker-cutting technique

Cutting banana suckers doesn't just happen anywhere; there is a special method or technique for cutting the suckers that grow from the stem of the parent and become the next generation after the main parent is harvested. Farmers must be innovative in selecting which offspring are more suitable as their parents' replacements and which are not.

According to farmers who are experienced in cultivating bananas, the correct technique and trick is to observe the development of the number of suckers that have been cut. For example, in one parent (clump) 4, suckers grow, then one sapling is chosen as the successor. At the same time, all three suckers must be cut to not interfere with the fruit's growth and ripening process and to avoid competition for nutrients between banana trees in the same grove. In one clump, if there are many suckers, it will reduce the yield (Robinson and Nel, 1990).

The requirements for the selected chicks are chicks that show their trunks are healthy and growing well and do not have any defects. If, after three cuttings, the sucker remains healthy and has good growth, then the sucker will be used as a successor to its parent, but if it is not good, it will be replaced with another, healthier sucker. After three cuttings, the offspring that will succeed the parent are not cut again until fertilization occurs.

"There is a separate technique for cutting the chicks; don't just cut them randomly or don't just cut them; there is a trick to choosing which chicks are more suitable to be potential broodstock; the good ones are to cut the chicks first then leave them, after they grow again then see which ones are the most fertile and give them a mark then cut them again up to three times, if it remains fertile then that is the candidate (successor) for the broodstock and the others are eradicated"

Participant P9 expressed this.

Banana suckers will be cut when the height is approximately 50 cm to 100 cm from the ground. The cutting method is to level them with the ground. Suckers that have been cut will grow back and increase the length of their stems and leaves and are allowed to grow with their parents.

"*It must be level with the ground when cutting the sucker and allowed to grow back with the parent. Cutting is done three times when the suckers have grown to a height of 50 cm to 100 cm,*" said P5

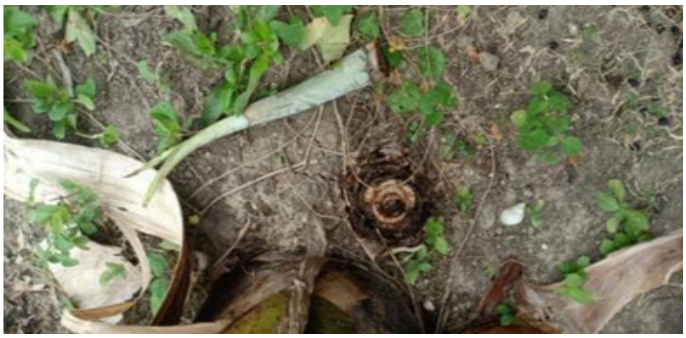

Figure 2: *Cutting banana suckers flat on the ground.*

When the seedlings are one month old, the stems reach a height of 100 cm with five leaves; then these seedlings are cut three times again, and then it is observed which viable (healthy and fertile) seedlings will be used as replacements (next generation) for their parents and at most two must be selected. According to most farmers, leaving only one chick in one clump is best. In contrast, the remaining chicks that are not needed must be cut (eradicated) continuously so as not to interfere with the growth of the parent in the fertilization process. This follows the research results of Purseth *et al*. (2022), which state that the optimal number of tillers allowed to grow with the mother is one tiller to produce high fruit.

The suckers that have been cut are allowed to grow as successors to the parent and will flower or develop cobs when the banana reaches 7 mo to 8 mo and will be harvested when the plant reaches 11 mo (physiologically mature). The growth of these suckers depends on the cultural factors, technical cultivation applied, and the application of hormones such as GA3,

Ethrel, and IAA (Bhende and Kurien, 2015).

Suckers that may be taken for sale (propagation material) are after the mother has already produced fruit, and it is not recommended to take seeds from the mother before they emerge from the cob because this can cause the mother tree to be attacked by disease originating from wounds left by cut suckers.

"*You are not allowed to sell suckers when the mother banana is in the process of ripening fruit or has not yet been harvested because it can cause the mother tree to be attacked by disease from incisions on the offspring" (P6). This farmer has been farming monoculture bananas for six years.*

Suckers must be cut specially; if there are four suckers and two suckers are needed, then the cutting method must be done using the interspersed method; suckers one and three are taken while suckers two and four are left to grow with their mother. The goal is that when the parent stem bears fruit, it gets support from its offspring so that it is sturdy and does not collapse easily when holding the weight of the large and heavy fruit bunches. Suckers taken before the banana flowers will cause the fruit on the parent to be small and the number of combs reduced. This will later impact traders' bargaining prices when assessing fruit using the slash system.

Trim the heart and peel the fruit petals

Other local knowledge applied by banana farmers is pruning part of the tip of the banana flower and the method of peeling the flower petals when the flower has emerged on the second top comb. The flower petals still covering the third comb must be peeled off so the fruit ripening process is faster than usual (without treatment). Another purpose of peeling flower petals is to increase the size of the fruit so that the bananas become more significant and the selling price will also increase. Apart from that, this peeling aims to make the appearance of the banana cleaner and smoother; there are no defects on the fruit, and they are even and the same size.

Before the flower petals open or a new banana heart emerges from the stem, which is still straight up, the heart must first be cut or circumcised 5 cm to 10 cm from the tip of the banana flower; from the incision, insecticide is applied. Farmers call it "Lanit (Lannate-insecticide)" so that the incision marks are not attacked by pests such as caterpillars, insects, bacteria, and the like, which will later damage the appearance of the banana, which will have an impact on the low selling price of the banana.

"*Cutting the banana heart while it is still straight up is also a means of applying insecticide so that it is not attacked by pests, which will damage the quality of the fruit and so that the pesticide can absorb into the banana flower,"* said participant P10.

Figure 3: *Trim part of the tip of the banana flower.*

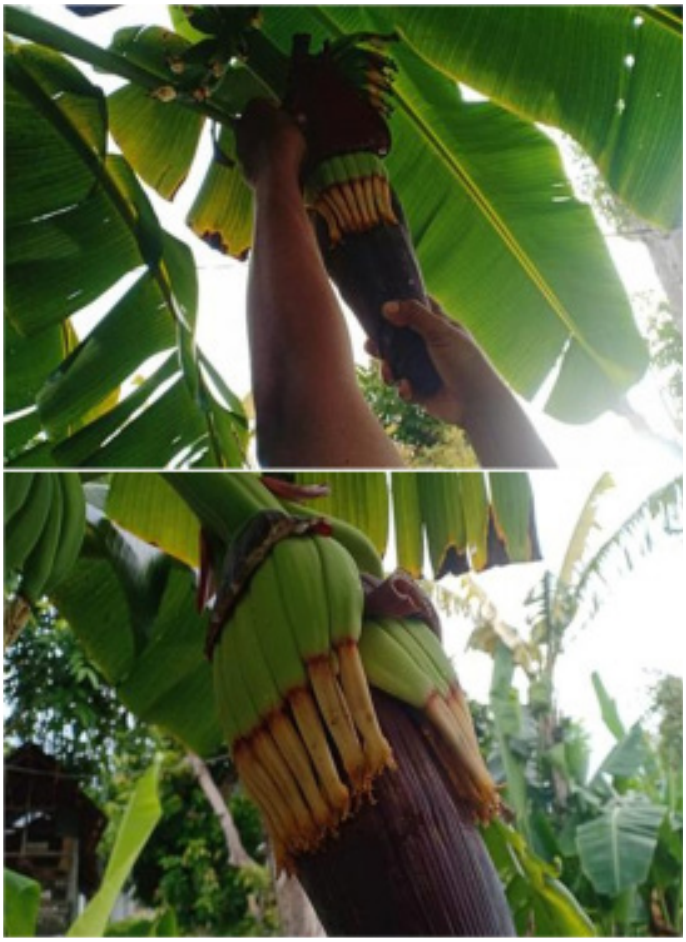

Figure 4: *Exfoliating flower petals.*

Cutting or pruning when the banana heart is still straight up serves so that the insecticide applied to the incision site can absorb into the banana heart.

Still, if you cut it when the heart is bent downwards, the medicine that is used will not be absorbed and may even be useless because it will drop out with it. Heart sap when freshly cut.

Economic benefits

The local wisdom applied by farmers certainly has economic benefits as an implication of the method used, including the sale of seeds from the cutting method; as explained above, buyers are more likely to look for suckers that have been cut than those that have never been cut. Suckers that have been cut will bear fruit more quickly than suckers that have never been cut, and the stems of the plants, when they bear fruit, are not too tall (short), making them easier to care for; this is the advantage of the sucker-cutting method. The price of sucker farmers sells ranges from IDR 8 000 to IDR 10 000. Sales proceeds from suckers certainly increase income from banana farming.

In terms of other economic benefits, if you cut the suckers in one cluster, there will be a lot of fruit combs (15 combs to 18 combs), and the size of the fruit will be significant at IDR 80 000 to IDR 100 000, even more than that with the super quality of the bananas. Meanwhile, parent bananas whose offspring have never been cut (allowed to grow without reduction) will have a small number of combs, around five combs to seven combs, or even less than that, resulting in a low selling price and the farmer's income automatically decreasing. Banana traders only value around IDR 40 000 to IDR 50 000.

A large number of combs and large fruit sizes will undoubtedly affect the bargaining power of buyers (banana traders), so farmers' income will also increase from banana farming. Income from selling bananas will be used to meet the family's needs so that if the family's needs are met, the family's welfare will increase.

Trimming the tip of the heart and peeling the cob petals also provides economic benefits because this treatment can speed up the ripening process, beautify the appearance of the fruit without spots (smooth), and increase the size of the fruit to be larger than usual. Production of fruit with a smooth appearance without spots will increase the selling price of bananas. The appearance of bananas that contain spots (spots, spots) will be priced cheaper by traders because they cannot enter the modern market whose consumers are dominated by the upper middle class.

Local knowledge still applied by the community has many benefits and uses for farmers, especially in banana cultivation. The application of local knowledge as the adoption of technological innovation in banana cultivation provides its advantages as an effort to increase income from farming so that family welfare will also increase because it meets family needs. (Pailis *et al*., 2020). Local knowledge is permanently preserved as part of the family's food security strategy (Leyva-Trinidad *et al*., 2021). Local wisdom plays a vital role in the life of farmers because, from their ancestors, this local wisdom has been passed down from generation to generation in farming so that they can produce food both for their consumption and for sale to increase family income.

Conclusions and Recommendations

Two forms of local knowledge to speed up fertilization are cutting off suckers and pruning or circumcising banana blossoms and peeling flower petals. The economic advantages for farmers include higher banana prices as a result of improved banana quality and income from selling planting materials created from cutting the suckers. Local knowledge regarding accelerated banana fruiting needs to be disseminated to farmers in other regions, considering the benefits of implementing it. Apart from that, this local knowledge needs to be preserved to support the sustainability of the food supply in the future, and further research needs to be done by applying this local knowledge technology, which is integrated with the application of biofertilizers to support production sustainability.

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Novelty Statement

Previous studies still rarely explore local knowledge related to the acceleration of banana fruiting. Local knowledge positively impacts the quality of yield and economic benefits for farmers. A qualitative approach can provide in-depth insights into local practices car-

ried out by banana farmers.

Author's Contribution

Hopid Hopid: Conducted the experiment, prepared the draft manuscript, and checked Grammarly.
Ida Ekawati: Conceptualized and designed the study, elaborated the intellectual content, performed literature search, and manuscript revision.
Isdiantoni Isdiantoni: Data visualization, supervision, and guarantor.
Habibi Habibi: Conducted the experiment, data analysis, language editing, and checked Turnitin.
Muhammad Zahoor and Patmawati Patmawati: Reviewed manuscript.
Nyono Nyono: Administration and searching the literature.
All authors have read and approved the final manuscript.

Conflict of interest
The authors have declared no conflict of interest.

Reference

Bhende, S.S and S. Kurien. 2015. Sucker production in banana. J. Trop. Agric., 53(2): 97–106.

Boillat, S and F. Berkes. 2013. Perception and interpretation of climate change among quechua farmers of bolivia: Indigenous knowledge as a resource for adaptive capacity. Ecol. Soc., 18(4): 21. https://doi.org/10.5751/ES-05894-180421

Braun, V and V. Clarke. 2019. Reflecting on reflexive thematic analysis. Qual. Res. Sport. Exerc. Heal., 11(4): 589–597. https://doi.org/10.1080/2159676X.2019.1628806

Cuevas-Mendieta, E., E. García-Frapolli and E. de l-Val. 2021. Diversity and local perception of lepidopterans in secondary tropical dry forests: Implications for management. For. Ecol. Manage., 482: 118815. https://doi.org/10.1016/j.foreco.2020.118815

Damat, D., R.H. Setyobudi., S. Anwar., M.A. Wedyan., Z. Vincevica-Gaile., Y.A. Nugroho., T. Liwang., T. D.N. Subchi., A. Fauzi., H.A. Manshur., D.D. Siskawardani., V.A. Wahyudi., Y.M. Ananda and H.A. Rachmawati. 2024. Coffee pulp characterization and utilization in coffee cherry flour for circular economy improvement. Sarhad J. Agric., 39 (Special issue 1): 71–83. https://doi.org/10.17582/journal.sja/2023/39/s1.71.83

Dimu-Heo, Y.H., D. Indradewa., E.T.S. Putra and B.H. Purwanto. 2022. Growth and yield of maize in t'sen, a local wisdom of planting in one planting hole, typical cropping pattern of West Timor's, Indonesia. Biodiversitas., 23(5): 2502–2511. https://doi.org/10.13057/biodiv/d230530

Donkoh, S and J. Mensah. 2023. Application of triangulation in qualitative research. J. Appl. Biotechnol. Bioeng., 10(1): 6–9. https://doi.org/10.15406/jabb.2023.10.00319

Dorel, M., G. Damour., N. Leclerc., S. Lakhia., S. Ricci., F. Vingadassalon and F. Salmon. 2016. Parent plant vs sucker – how can competition for photoassimilate allocation and light acquisition be managed in new banana hybrids? F. Crop. Res., 198: 70–79. https://doi.org/10.1016/j.fcr.2016.08.028

Endayani, H. 2023. Local wisdombased education model. Pema Jurnal 3(1): 25–32. https://doi.org/10.56832/pema.v3i1.321

Fu, X., X. Wang., C. Schock and T. Stuckert. 2016. Ecological wisdom as benchmark in planning and design. Landsc. Urban Plan., 155: 79–90. https://doi.org/10.1016/j.landurbplan.2016.06.012

Goulet, F. 2013. Narratives of experience and production of knowledge within farmers' groups. J. Rural Stud., 32: 439–447. https://doi.org/10.1016/j.jrurstud.2013.09.006

Hadinoto, H., L. Zalizar., J. Triwanto., E. Ervayenri., R.H. Setyobudi., M. Chanan., N.T. Waskitho., J.T. Ibrahim., E. Suhesti., N.V. Minh., R. Tonda., S. Satrio and T.A. Pakarti. 2023. Bird diversity, abundance, and evenness rates in ecotone area of Sutan Syarif Hasyim forest park, Riau, Indonesia. E3S Web of Conf.374 (00014):1–9. https://doi.org/10.1051/e3sconf/202337400014

Hong, S., H. Jv., M. Lu., B. Wang., Y. Zhao and Y. Ruan. 2020. Significant decline in banana Fusarium wilt disease is associated with soil microbiome reconstruction under chilli pepper-banana rotation. Eur. J. Soil Biol., 97: 103154 https://doi.org/10.1016/j.ejsobi.2020.103154

Iniesta-Arandia, I., D.G. del Amo., A.P. García-Nieto., C. Piñeiro., C. Montes and B. Martín-López. 2014. Factors influencing local ecological knowledge maintenance in Mediterranean watersheds: Insights for environmental policies. Ambio., 44(4): 285–296. https://doi.

org/10.1007/s13280-014-0556-1

Leyva-Trinidad, D.A., A. Pérez-Vázquez., G.E. Newell., J.C.G. Albarado and A.G. Jácome. 2021. Food security strategies of an indigenous community in Veracruz, Mexico. Ethnobiol. Conserv., 10: 41. https://doi.org/10.15451/ec2021-11-10.41-1-16

Mane Kandari, A., H. Hidrawati., U. Rianse., M. Muhidin., M. Iswandi and N. Arafah. 2017. Local wisdom as adaptation strategy in suboptimal land management at Binongko island, Wakatobi Indonesia. Biosci. Biotechnol. Res. Asia., 14(1): 129–136. https://doi.org/10.13005/bbra/2427

Mariani, D and Usmeldi. 2019. Needs analysis in the development of natural science student books connected type integrated of local cultural wisdom. J. Phys. Conf. Ser., 1185. 012071. https://doi.org/10.1088/1742-6596/1185/1/012071

Miles, M.B., A. Huberman and J. Saldana. 2016. Qualitative data analysis a methods sourcebook. In SAGE (3rd ed.). Sage Publications, Inc.

Morgan, D.L and A. Nica. 2020. Iterative thematic inquiry: A new method for analyzing qualitative data. Int. J. Qual. Methods., 19: 1–11. https://doi.org/10.1177/1609406920955118

Murhaini, S and Achmadi. 2021. The farming management of Dayak people's community based on local wisdom ecosystem in Kalimantan Indonesia. Heliyon, 7(12): 08578. https://doi.org/10.1016/j.heliyon.2021.e08578

Noble, M.M., D. Harasti., C.J. Fulton and B. Doran. 2020. Identifying spatial conservation priorities using traditional and local ecological knowledge of iconic marine species and ecosystem threats. Biol. Conserv., 249: 108709. https://doi.org/10.1016/j.biocon.2020.108709

Pailis, E.A., Fatkhurahman and A. Arif. 2020. Indigenous community approach through indigenous leader social entrepreneurship in five Luhak in Rokan Hulu regency Riau Indonesia. Int. J. Sci. Technol. Res., 9(3): 5249-5255.

Petsakos, A., S.D. Prager., C.E. Gonzalez., A.C. Gama., T.B. Sulser., S. Gbegbelegbe., E.M. Kikulwe and G. Hareau. 2019. Understanding the consequences of changes in the production frontiers for roots, tubers and bananas. Glob. Food Sec., 20: 180–188. https://doi.org/10.1016/j.gfs.2018.12.005

Prasetyo, H., D. Karmiyati., R.H. Setyobudi., A. Fauzi., T.A. Pakarti., M.S. Susanti., W.A. Khan., L. Neimane and M. Mel. 2022a. Local rice farmers attitude and behavior towards agricultural programs and policies. Pakistan J. Agri. Res., 35(4): 663–677. https://doi.org/10.17582/journal.pjar/2022/35.4.663.677

Prasetyo, H., R.H. Setyobudi., P.G. Adinurani., Z. Vincēviča-Gaile., A. Fauzi., T.A. Pakarti., R. Tonda., N.V. Minh and M. Mel. 2022b. Assessment of soil chemical properties for monitoring and maintenance of soil fertility in Probolinggo, Indonesia, Proc. Pak. Acad. Sci.: B. 59(4), 99–113. https://doi.org/10.53560/PPASB(59-4)811

Purseth, K., S.E. Topno and V. Bahadur. 2022. Effect of optimized number of suckers and use of PGR on growth, yield and quality of banana (*Musa paradisiaca* L.) cv. Udhayam. Int. J. Environ. Clim. Chang., 12(11): 2917–2928. https://doi.org/10.9734/ijecc/2022/v12i1131284

Putri, D.C., A. Munandar and B. Supriatno. 2019. The implementation of indigenous people local wisdom Lekuk 50 Tumbi in managing agriculture and lakes as biological learning sources. J. Phys. Conf. Ser., 1157(2): 1–6. https://doi.org/10.1088/1742-6596/1157/2/022095

Rawluk, A and M.E. Saunders. 2019. Facing the gap: Exploring research on local knowledge of insect-provided services in agroecosystems. Int. J. Agric. Sustain., 17(1): 108–117. https://doi.org/10.1080/14735903.2019.1567244

Robinson, J.C and D.J. Nel. 1990. Competitive inhibition of yield potential in a "Williams" banana plantation due to excessive sucker growth. Sci. Hortic., 43(3–4): 225–236. https://doi.org/10.1016/0304-4238(90)90094-U

Ronner, E., G.J. van de Ven., K. Nowakunda., J. Tugumisirize., J. Kayiita., G. Taulya., G. Uckert and K.K.E. Descheemaeker. 2023. What future for banana-based farming systems in Uganda? A participatory scenario analysis. Agric. Syst., 209: 103669. https://doi.org/10.1016/j.agsy.2023.103669

Schwann, A. 2018. Ecological wisdom: Reclaiming the cultural landscape of the Okanagan Valley. J. Urban Manag., 7(3): 172–180. https://doi.org/10.1016/j.jum.2018.05.004

Shepherd, C.J. 2010. Mobilizing local knowledge and asserting culture: The cultural politics of

in situ conservation of agricultural biodiversity. Curr. Anthropol., 51(5): 629–654. https://doi.org/10.1086/656424

Thomas, E., M. Riley and J. Spees. 2020. Knowledge flows: Farmers' social relations and knowledge sharing practices in 'catchment sensitive farming.' Land Use Policy., 90: 104254. https://doi.org/10.1016/j.landusepol.2019.104254

Wibowo, A., A. Setyawati., G. Masyithoh and E.S. Rahayu. 2021. Local wisdom in the preservation and diversification of medicinal plant use (A case study of the Lawu mountain side community on the island of Java, Indonesia). IOP Conf. Ser. Earth Environ. Sci., 905(012025): 1–8. https://doi.org/10.1088/1755-1315/905/1/012025

Wicaksono, A., I. Yunita and G. Ginaya. 2022. Living side by side with nature: Evidence of self-governance in three local communities in Indonesia. Heliyon., 8(12): 12248. https://doi.org/10.1016/j.heliyon.2022.e12248

Widodo, W., A. Sutanto., I.D. Rahayu., A.D. Anggraini., T. Handayani., R.H. Setyobudi., M. Mel and N.N. Huu. 2023. Herbs as a feed additive in the broilers for the sustainability of local products. E3S Web Conf. 374 (00037): 1–6. https://doi.org/10.1051/e3sconf/202337400037

Zulfikar, Z., S.N. Qomariyah and D.A. Huzeni. 2021. Assessing the economic potential of banana production on critical land in Plandaan sub-district, Jombang regency. Sigmagri., 2(02): 112–120. https://doi.org/10.32764/sigmagri.v2i02.828