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Knowledge Enhancement Among Members of the Women Farmers Group (WFG) through Islamic Science-Based Soil Ecology Education

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Abstract:

Farmers' knowledge about soil ecology, which is a key factor in increasing the productivity of agricultural products, needs to be evaluated considering that various counseling efforts to increase agricultural yields have not shown satisfactory results. Farmers still unequally manage farmland, providing excessive chemical fertilizers without regard to soil ecology. The purpose of this education is to evaluate the knowledge of the Women's Farmers Group (WFG) before and after conducting soil ecology education based on Islamic science. The subjects of this education were 15 members of WFG Bunga Padi, Jorong Kawai, Nagari Batu Bulek, Lintau Buo Utara, Tanah Datar, West Sumatra, Indonesia. The community-based research (CBR) approach is used in this educational activity. The stages of educational activities start from socialization, laying the basis of the research and the research design, providing pretests and materials, gathering information and analyzing data on biological factors, capillarity of groundwater, water holding capacity, soil aeration, soil fertility, and soil pH, and the evaluation (post-test). The results show an increase in knowledge and understanding among WFG Bunga Padi members after Islamic science-based soil ecology education. It is hoped that, over time, their mindset in managing farmland will be balanced, with less reliance on chemical fertilizers and more emphasis on soil ecology. As a result, Islamic science-based soil ecology education could have a role in improving farmland and laying the foundation for organic farming.

Keywords: *Empowerment, Farming Women's Group*, *Islamic Science, Organic Agriculture*, *Soil Ecology*

Introduction

Soil can be defined as a mixture of minerals and organic particles with various sizes and compositions closely associated with plant growth. Particles occupy approximately 50 percent of the soil volume. The remaining soil volume, about 50 percent, constitutes pore spaces, consisting of pores of various shapes and sizes (Foth 1990). These pore spaces contain air and water, serving as channels for air and water movement. They also function as habitats for small organisms and as areas for root extension and growth. Roots play a crucial role in supporting plants and absorbing water, and nutrients. For optimal plant growth, the root-soil environment must be free from inhibiting factors (Mustafa et al. 2012; Zeynab et al. 2017; Laisshram et al., 2015), such as toxic substances, disease-causing organisms, impermeable soil layers, extreme temperatures, acidity or alkalinity, or excessive salt content. The green revolution in agriculture, characterized by the application of modern technology three decades ago, has boosted agricultural food production. However, it has led to damage to agricultural lands (Yuliana 2020; Reganold and Wachter 2016; Saad, 2021). This damage is a result of techniques and the use of chemical fertilizers without sufficient knowledge. Degraded soil becomes impenetrable by roots, soil water retention capacity decreases, toxic substances accumulate in the soil, and small soil-dwelling organisms face extinction. Consequently, this situation leads to unproductive crops and financial losses for farmers.

There have been numerous government efforts and initiatives aimed at improving these degraded agricultural lands. Various extension and training programs conducted by agricultural extension workers and universities have been implemented for farmers. These programs include initiatives such as the introduction of biochar to rehabilitate critical lands (Widowati, Pudjiastuti, and Sa'diyah 2020), the production of organic fertilizers (Oktavia et al., 2020; Fahrizal et al., 2021), land processing innovations (Ramadhana and Subekti 2021), land optimization, integrated farming system applications (Konawe 2022), and the management of natural fertilizers and pesticides (Puu et al.

2019). However, until now, these programs have yet to show significant improvements in agricultural land productivity, as indicated by the persistently low agricultural output. In practice, farmers generally continue to cultivate agricultural land based solely on instinct and experience. The knowledge gained from various agricultural extension and training activities has not been fully applied. Land productivity significantly influences agricultural output enhancement (Foth 1990; Setyorini et al., 2003; Mozumdar, 2012). Therefore, there is a need for additional efforts to ensure that government programs aimed at improving farmers' welfare through land rehabilitation programs are more effective. One approach is to enhance farmers' knowledge about soil and soil ecology for farmers.

Soil ecology plays a vital role in soil fertility and agricultural productivity (Bhardwaj et al. 2014; Laisshram et al., 2015). Supriyadi et al. (2021) reported that providing knowledge about soil ecology has the potential to raise farmers' awareness regarding the significance of balanced land cultivation. Hadiyanti et al. (2022) reported that communities are interested in applying organic materials in their farming endeavors after receiving village ecology education. Farmer groups represent one of the most feasible partners to receive education as they share common visions and goals, making dissemination to other farmers easier. One such farmer group in Tanah Datar is the Women Farmers Group (WFG) Bunga Padi, located in Jorong Kawai, Kenagarian Batu Bulek, Lintau Buo Utara district.

WFG Bunga Padi was established in 2017 and remains active to this day. It is one of the WFGs that has received numerous trainings and empowerment initiatives, as well as assistance from local government or related agencies, aimed at improving the welfare of its members. Their training includes solid compost fertilizer production, liquid compost fertilizer, the cultivation of Lintau rice, among others. However, in reality, they still tend to lean towards conventional farming, fertilizing plants based on instinct and experience, neglecting the aspects of soil ecology. For this reason, it is necessary to provide soil ecology

education designed based on Islamic science. The general objective of this soil ecology education is to enhance the knowledge of WFG Bunga Padi members about soil ecology, thereby altering their mindset in managing their agricultural land. The specific objective is to evaluate the knowledge of the women farmers' group before and after the implementation of Islamic science-based soil ecology education.

Method

The Islamic Science-based soil ecology education was conducted from October 12 to November 2, 2022, at the Women Farmers Group (WFG) Bunga Padi in Jorong Kawai, Nagari Batu Bulek, Lintau Buo Utara District, Tanah Datar Regency, West Sumatra. The implementation method included various phases: socialization, self-evaluation at the beginning of the activity, soil ecology parameter practice/observation, final self-evaluation, discussions, and documentation. The execution phases utilized a Community-Based Research (CBR) approach. The specific steps involved were as follows:

Phase 1: Socialization.

This phase involved initial exploration and communication between the Community Service Team and the Head of Jorong Kawai and the Chairperson of WFG Bunga Padi (first Focus Group Discussion/FGD). The meeting focused on introducing and explaining the goals and benefits of the community service activity to the Chairperson of WFG Bunga Padi and the Head of Jorong Kawai. The face-to-face meeting took place on October 12, 2022. The FGD revealed the understanding of soil and farming management practices among the Chairperson and how they predominantly relied on instinct and experience. The outcomes of the first FGD also covered discussions on the implementation method, involved members, but a schedule for the implementation was not yet finalized.

Stage 2: Laying the research foundation and establishing the research design (phases 1 and 2 of CBR).

During the second meeting, FGD was conducted with the Chairperson of WFG Bunga Padi on October 18, 2022, focusing on the technical aspects of the activity implementation. This meeting resulted in an agreement regarding the Community Service Program activities and the empowerment approach to being employed. In this service approach, we reached a consensus to use CBR approach. The empowerment team, together with the Chairperson of WFG Bunga Padi, successfully identified and recognized the obstacles to rehabilitating their degraded agricultural land. This empowerment approach recommends the necessity of soil ecology education with an scientific Islamic approach. The agreed-upon research formulation was to understand the knowledge of WFG Bunga Padi members regarding soil ecology. The educational activities were conducted using Islamic science-based soil ecology materials. The ultimate goal was to enhance the knowledge of WFG Bunga Padi members about soil ecology, encouraging them to consider soil ecology factors in managing their agricultural land.

The involved parties decided to include 15 members of WFG Bunga Padi. The activity was scheduled for two days, namely on October 31 and November 1, 2022, to be held at the Deputy Chairperson's residence of WFG Bunga Padi. The research activity design and data analysis were also determined during this phase.

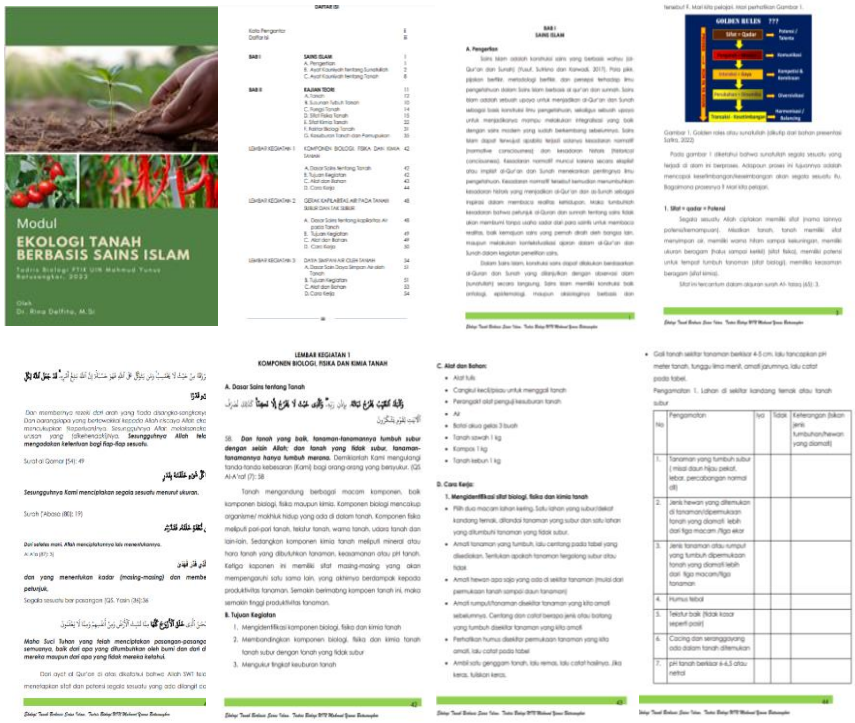
Stage 3: Initial evaluation (pre-test) and material delivery.

This stage involves conducting a pre-test, delivering materials, engaging in discussions sessions, gathering information, and analyzing data. The pre-test aims to ensure the knowledge and understanding of WFG Bunga Padi members regarding soil, identifying characteristics of unhealthy and healthy soil, good soil management practices, and ways to rehabilitate degraded soil. Following the completion of the pre-test, modules are distributed and the material is presented (Figure 1). The modules have been designed in a way to facilitate their documentation

of the research findings. The primary research activity involves distinguishing between fertile and unhealthy soil using parameters related to soil biology, chemistry, and physics. After completing the pre-test questionnaire, distributing modules, and providing PowerPoint materials, the presentation of the educational material commences.

The delivery of materials was carried out by using the Qur'an and Sunnah as the basis for constructing knowledge about soil and soil ecology, while simultaneously integrating it with previously established modern science. The material explanation begins with an introduction to Islamic science discussing the concept of 'sunatullah' or natural laws, encompassing (1) the everything has potential including soil and living organisms (plants/animals/bacteria/fungi); (2) the potential of soil/living organisms to exert influence on their surrounding environment; (3) the impact of soil and living organisms leading to interactions; (4) interactions between soil/living organisms and the environment resulting in changes; (5) changes in soil/living organisms leading to achieving balance. This conceptual framework was utilized in analyzing the soil observation results conducted by WFG Bunga Padi. The delivery of this Islamic science framework and concept was supported by an ecology module designed based on Islamic science, facilitating the comprehension of the material for WFG Bunga Padi members.

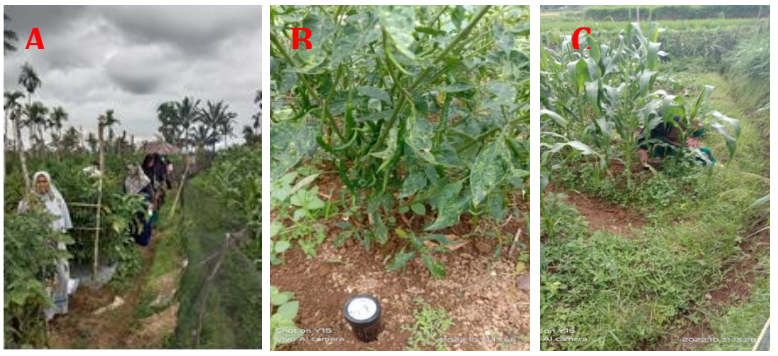
Figure 1.
Soil Ecology Module based on Islamic Science.



Stage 4: Gathering information and data analysis (the third stage of CBR).

The collaborative research activities with WFG Bunga Padi aimed to distinguish between healthy and unhealthy soils were conducted following the guidelines provided in the previously designed module, which outlined the steps for conducting the research. The observed aspects included biological factors, soil physics (capillarity, water retention, and soil aeration), and soil chemistry (soil fertility, pH levels). The tools, materials, and procedural steps were all detailed within the module. Researchers from the university, alongside members of WFG Bunga Padi, conducted the research collectively, recording observation outcomes in the designated modules provided to each member.

Figure 2.
A and C = Observation of fertile and infertile/unhealthy soil biological factors. B = Measurement of soil pH.



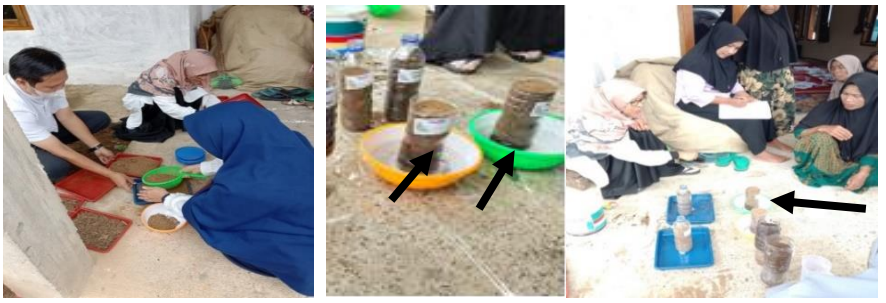
In addition to direct field observations of soil biological factors and soil pH, a simple plot simulation in the paddy field was conducted through basic testing. The tests involve soil fertility assessment, soil capillarity, water retention capacity, and soil aeration. The activity concerning soil fertility testing can be observed in Figure 3.

Figure 3.
Simple soil fertility test

The capillarity test of granulated garden soil compared to granulated garden soil mixed with organic material/compost can be seen in Figure 4.

Figure 4.

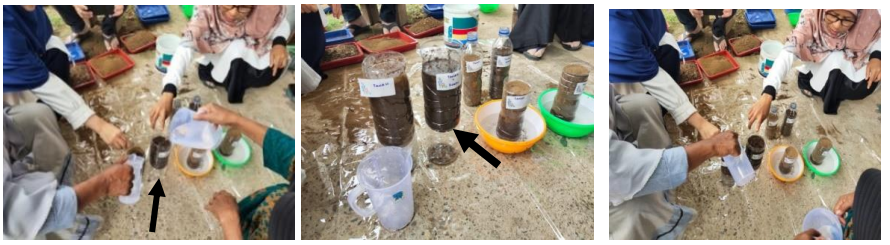
Capillarity test of garden soil and garden soil with compost. A= Initial soil preparation; B= Testing, and C= Observation of results.



Collaborative research with other WFG members involved testing the water retention capacity of the soil, as shown in Figure 5. In Figure 5, it's evident from the testing that the water retention capacity of granulated sandy garden soil is lower, indicated by slow water absorption and prolonged surface water pooling. Conversely, the granulated garden soil mixed with compost/organic material demonstrates higher water retention capacity, characterized by rapid water absorption and minimal surface water pooling.

Figure 6.

Soil water retention test.

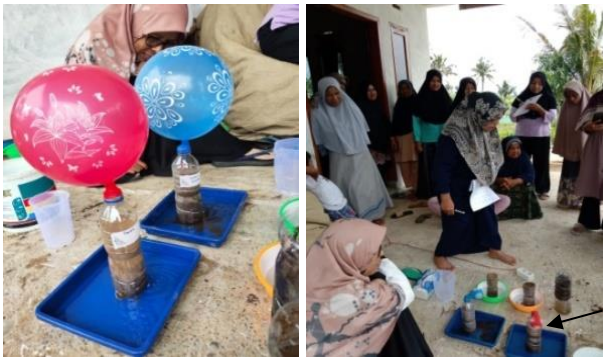


Air circulation testing within the soil (aeration) was also conducted to understand the influence of organic materials on soil air circulation, closely related to the life of soil flora and fauna. This soil aeration test involves using granulated garden soil and granulated garden soil mixed with organic material. The procedure involved two medium-sized water bottles with holes, filled with different types of soil. Then, inflate a balloon and place it over each bottle's mouth. Each

bottle was placed in a tray filled with water. Subsequently, observe the balloons and air bubbles in the tray containing water. The testing process is illustrated in Figure 6.

Figure 6.

Soil aeration test (on the left). A member is observing and explaining the results of the soil ecology aspect test.



Stage 5. Action Formulation.

This stage involves formulating actions based on the data obtained (Stage 4 of CBR), conducted on November 1, 2022. The data collected the previous day and recorded in the modules were discussed, followed by seeking solutions or recommendations to be implemented by WFG Bunga Padi members. All members are responsible for the agreed-upon recommendations to be implemented within the community. From the discussion results regarding the previous day's observation data, it was apparent that WFG members were enthusiastic about asking questions and acknowledged their past mistakes. The ultimate outcome of this step is their commitment to gradually implement tangible soil improvement actions after this educational activity.

Stage 6. Final Evaluation/Post-test.

This evaluation stage is conducted by providing questionnaires related to their understanding of soil ecology after the educational session.

Result

General Conditions of the Community Service Location

Kawai is one of the sub-districts (Jorong) in Kenagarian Batu Bulek, North Lintau Buo District, Tanah Datar Regency, West Sumatra. The altitude of this sub-district is 550 meters above sea level. The average rainfall is 278 mm per year with an average temperature ranging between 27°-30° Celsius. The community of Jorong Kawai is predominantly comprised of economically disadvantaged individuals. Their primary livelihood is farming, and generally, the education level within the community remains low. The population of Jorong Kawai totals 1,568 individuals, covering an area of 2.57 square kilometers (tanahdatar.go.id). Women (wives) actively participate in farming activities alongside their husbands. Many of these female farmers are part of various farming groups.

There are 33 farming groups in Kenagarian Batu Bulek. Only one women's farming group exists in Jorong Kawai and remains active until now, namely the WFG Bunga Padi. WFG Bunga Padi was established in 2017 and consists of 22 members. Their vision is to become a strong, self-reliant, fair, and prosperous farming group in managing natural resources. WFG Bunga Padi has received considerable agricultural education from the Agricultural Extension Team. The educational content provided by the Agricultural Extension Team includes topics related to the application of SRI (System of Rice Intensification) technology, composting for plant diseases, and their remedies. However, they have not yet received education specifically focused on the soil ecosystem, which is fundamental for enhancing crop productivity.

The knowledge of WFG members before and after the implementation of Islamic science-based soil ecology education.

Based on the questionnaire sheets assessing soil ecology knowledge distributed at the beginning and end of the activity, an overview of the knowledge of WFG Bunga Padi members was obtained (Table 1). Based on Table 1, it is evident that generally, the members of WFG Bunga Padi already have a reasonable level of

knowledge regarding soil facts, soil ecology, soil improvement procedures, and the ability to correlate information about soil before receiving Islamic science-based soil ecology education. This is observed from their average percentage of knowledge before the education, which was 75.57%. Their knowledge about soil facts was the highest (94.67%), while the lowest was in the soil ecology concept, specifically the soil physics factor (50.83%), followed by their ability to correlate information about soil (63.33%).

Table 1.
Knowledge of WFG Members Before and After Islamic Science-Based Soil Ecology Education

Knowledge	Before education (%)	After Education (%)	Gain (%)
Facts about soil	94.67	97.33	2.66
Soil Ecology Concepts			
- Soil Biological Factors	78.67	97.33	18.66
- Soil Physical Factors	50.83	70	19.17
- Soil Chemical Factors	83.33	88.33	5
Mean	70.94	85.22	14.28
Soil improvement procedures	73.33	100	26.67
Ability to correlate various information about soil	63.33	88.33	25
Mean	75.57	89.51	17.15167

Table 1 also reveals that the Islamic science-based soil ecology education added to the knowledge and understanding of WFG Bunga Padi members about soil ecology. Before the activity, their knowledge and understanding of soil ecology were relatively sufficient (75.57%); however, after the educational session, their knowledge and skills increased significantly, reaching a very good level (89.51%), as expected. Interviews conducted at the end of the activity indicated that they had just realized that fertile soil could retain a substantial amount of water within the soil, not just on the surface. They became aware of the urgent

need to improve their soil quality. The enhancement in knowledge and awareness among WFG Bunga Padi members signifies a knowledge transfer and the development of an awareness about the importance of understanding soil ecology for achieving productive land and fostering sustainable agriculture.

Discussion

The outcome of the community service conducted revealed that the knowledge of the women farmer group about soil ecology/system prior to the service was fairly good. Nonetheless, this knowledge didn't significantly enhance the productivity of their farmlands. Their agricultural land management still relies on instinct and experience. Their attention was primarily focused on making their plants fertile, ignoring soil ecology, a key factor in their agricultural land's productivity. They believed that chemical fertilizers were better and quicker in affecting their crops. They had not yet realized that excessive use of chemical fertilizers without the addition of organic materials to their farmland could damage the soil.

Their low knowledge on this aspect is quite reasonable due to not only their low educational level but also their strong belief in their ancestors' farming methods. Education can greatly influence a person's mindset and their acceptance of information regarding soil (Gusti, Gayatri, and Prasetyo 2022; Braito et al. 2020). The level of knowledge, attitudes, and skills of farmers significantly influences both jointly and partially the productivity of agricultural land and agricultural production (Fadhilah, Eddy, and Gayatri 2018; Reimer et al. 2023). Another factor contributing to their low knowledge of soil, especially in the aspect of soil physics, is the lack or absence of soil ecology education. Pratiwi & Sudrajat, (2012); Dessart, Barreiro-Hurlé, and Van Bavel (2019) reported that significant factors influencing farmers' behavioral tendencies in managing agricultural land are farmers' age, years of farming, agricultural extension services, the purpose of farming activities and the farmer's lifestyle.

Following the educational activity based on Islamic science, elucidating the concept of soil according to the Qur'an and Hadith, along with science, it was found that it increased the knowledge and understanding of WFG Bunga Padi members about soil ecology. They became aware of how to manage agricultural soil properly as stated in the Qur'an and Hadith. The knowledge and understanding of soil ecology among WFG Bunga Padi members before the activity were relatively adequate (75.57%); however, after the Islamic science-based soil ecology education, their knowledge increased as expected, reaching a very good level (89.51%). Interviews conducted at the end of the activity revealed that they had understood that fertile soil could retain a significant amount of water within the soil, not just on the surface. They realized that their soil urgently needed improvement. The increase in knowledge and awareness among WFG Bunga Padi members indicates knowledge transfer and the construction of awareness about the importance of understanding soil ecology for creating productive land and sustainable agriculture. They were determined to balance fertilizer application for plants and soil maintenance to enhance their crop productivity by adding organic materials. In other words, the Islamic science-based soil ecology education provided to WFG Bunga Padi members helped change their mindset about the necessity of paying attention to soil ecology through the application of organic materials to the soil, apart from fertilizing the plants. Increased knowledge will influence a better mindset (Wahyuni et al., 2021) and value-belief-norms that farmers have (Rezaei-Moghaddam, Vatankhah, and Ajili 2020). Mindset and value-belief-norms that farmers have will affect farmers' behavior in managing their agricultural land (Pratiwi and Sudrajat 2012). Hadiyanti et al., (2022) reported that people were interested in applying organic materials in their agricultural endeavors after receiving ecological village education.

Thus, Islamic science-based soil ecology education conducted with a CBR approach was able to enhance the knowledge of WFG members regarding soil ecology and could change their farming

mindset and behavior to focus on soil ecology as specified in the Qur'an and Hadith. Nonetheless, our education still has shortcomings, as there has been no further evaluation regarding their actual actions taken.

Conclusion

Based on the results of community service activities, it is concluded that generally, the knowledge of WFG Bunga Padi members before receiving education was adequate (75.57%), and after the implementation of Islamic science-based soil ecology education, their knowledge significantly improved to very good (81.59%). The presentation of soil ecology material based on verses from the Qur'an and Hadith regarding soil and its ecology, along with guidance through the Islamic science-based soil ecology module containing explanations of Qur'anic verses and Hadiths, combined with worksheets they had to complete during observation of their agricultural soil, substantially transformed the mindset of WFG Bunga Padi members regarding the importance of soil and its ecology. Therefore, Islamic science-based soil ecology education enhanced the knowledge of WFG members regarding soil ecology, its role in agricultural productivity, and altered their perception of healthy soil.

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