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Development of a training manual to enhance agriculturists' knowledge and skills in using African nightcrawler earthworm fertilizer for environmental conservation

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ABSTRACT

The aim of this research was to create a training manual that promotes the use of African nightcrawler earthworm fertilizer for environmental conservation among agriculturists. Additionally, the study aimed to compare the knowledge, attitudes, and skills related to using African nightcrawler earthworm fertilizer for environmental conservation before and after training. The sample included 30 agriculturists from Ban Han, Moo 4, Kwao sub-district, Muang district, Maha Sarakham province. Research instruments included a training manual, knowledge test, attitude test, and skills test related to the use of the fertilizer. Data were analyzed using percentage, mean, standard deviation, and paired t-test with a statistical significance level of .05. The findings were as follows: 1) The training manual was found to be effective, with an efficiency rate of 88.93/81.07, meeting the established criteria. Agriculturists showed a 65.15% improvement in their knowledge of African nightcrawler earthworm fertilizer for environmental conservation after using the manual. 2) The agriculturists' average scores in knowledge, attitude, and practical skills related to using the fertilizer were significantly higher after training, with a statistical significance level of .05.

1. Introduction

Organic agriculture is a farming system that relies on ecological principles to manage production. It integrates biodiversity from plants, livestock, fisheries, and forests to enhance and recycle natural resources within the ecosystem, aiming to reduce the need for imported materials and synthetic chemicals like fertilizers, pesticides, hormones, and antibiotics (Reganold and Wachter, 2016). Organic farming is productive, nutrient-rich, non-toxic, and cost-effective. Vermicompost is also used as a key input in organic farming. It improves soil moisture retention, loosens the soil, promotes root growth and spread, and ensures good drainage and aeration (Lazcano and Domínguez, 2011).

Earthworms are segmented invertebrates classified under Phylum Annelida, Class Chaetopoda, Order Oligochaeta, and Family Lumbricidae, with around 1,800 species identified. Common species in Thailand and Southeast Asia include *Pheretima peguana* and *Pheretima posthuma*, none of which are known to transmit pathogens to humans or animals (Hendrix and Bohlen, 2002). Earthworms are composed of about 80% water, breathe through their skin, are highly sensitive to light, and break down organic material, producing natural fertilizer as waste. The African nightcrawler is particularly effective for aquaculture, being large, quick-moving, and capable of climbing pond edges, making it ideal for widespread farming, especially as a protein source for animal feed. Earthworms provide significant agricultural benefits. They aerate and mineralize the soil by bringing nutrients from lower layers to the surface. This activity enhances soil quality, allowing plants to access decomposed organic matter and promoting microbial growth that is beneficial to plants. The burrowing also improves soil structure, allowing better water and air

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movement and creating spaces that support root growth and spread (Sasaki et al., 2010).

Earthworms are soil-dwelling organisms that play a crucial role in breaking down plant debris and organic matter, enhancing soil structure, and facilitating water drainage (Ström et al., 2005). When soil is moist, earthworm activity also helps with water evaporation. However, beneficial earthworms are becoming less common, so increasing their populations is essential. Vermicast compost production yields three products: 1) vermicast compost, 2) vermicompost slurry, and 3) additional earthworms. Vermicompost is nutrient-rich and immediately available for plant use. Climate change poses a significant threat to biodiversity, impacting ecosystems through shifts in temperature and rainfall patterns. Earthworms are vital to tropical and warm-zone soils, where they often make up 40–90% of soil-dwelling organisms. Being poikilothermic, their body temperature fluctuates with the environment, so their growth, metabolism, respiration, and reproduction are directly influenced by temperature changes, which can affect their survival and role in soil ecosystems (Singh et al., 2019).

According to Singh et al. (2019), the minimum and maximum temperatures at which earthworms can survive range between 25°C and 35°C. At these temperature extremes, earthworms experience oxidative and nitrative stress. Supplementing their diet with antioxidant polyphenols from medicinal plant leaves, such as mulberry, almond, and cassava, may reduce these stresses. This study aimed to investigate how temperature, environmental conditions, and polyphenols affect the growth efficiency and biochemical markers (FRAP, MDA, H_2O_2, and NO) of African nightcrawler earthworms. Using natural antioxidants could help manage earthworm cultivation in challenging climates. This research also seeks to promote the use of African nightcrawler earthworm fertilizer for environmental conservation by training agriculturists. To support this, training activities were organized in Ban Han, Moo 4, Kwao Sub-district, Muang District, Maha Sarakham Province, to encourage agriculturists to adopt these beneficial practices.

Currently, the climate, especially the continuously increasing environmental temperature, is a problem for living things, including earthworms. Studying the impact and solutions to these problems will help increase the efficiency of African nightcrawler earthworm production for environmental conservation for farmers. Training and promotion of the use of earthworm fertilizer can develop the people who participate in the program to have knowledge, understanding, and a positive attitude towards earthworm farming, as well as skills in applying it, which will be useful in solving the current environmental problems, leading to sustainable coexistence between humans and the environment (Singh et al., 2019).

The current climate, particularly rising environmental temperatures, poses challenges for many organisms, including earthworms. Research on these impacts and potential solutions could help improve the production efficiency of African nightcrawler earthworm fertilizer, supporting environmental conservation efforts by agriculturists (Rahman et al., 2019). Training programs that promote earthworm fertilizer use can enhance participants' knowledge, foster positive attitudes toward earthworm farming, and build practical skills. These developments can empower individuals to address environmental challenges, contributing to a more sustainable coexistence between humans and the environment. The research purposes are as follows:

1. To develop a training manual to promote the use of African nightcrawler earthworm fertilizer for environmental conservation for agriculturists.
2. To compare the knowledge, attitude, and skill of using African nightcrawler earthworm fertilizer to environmental conservation for agriculturists before and after training.

2. Method

The research population consisted of agriculturists from Ban Han, Moo 4, Kwao Sub-district, Muang District, Maha Sarakham Province, with 314 males and 301 females, totaling 615 individuals (Maha Sarakham Province Statistical Report, 2563:1). The sample included 30 agriculturists from the same location, who volunteered to participate in the training program after it was promoted through local community leaders. The independent variables of this study are:

1. Training manual on using African nightcrawler earthworm fertilizer for environmental conservation for agriculturists.
2. The dependent variables are:

a. Knowledge about using African nightcrawler earthworm fertilizer for environmental conservation for agriculturists.
b. Attitude to using African nightcrawler earthworm fertilizer to environmental conservation for agriculturists.
c. Skill in using African nightcrawler earthworm fertilizer to environmental conservation for agriculturists.

2.1. Research tools

1. A training manual for using African nightcrawler earthworm fertilizer for environmental conservation for agriculturists.
2. A knowledge test of the use of African nightcrawler earthworm fertilizer.
3. An Attitude measurement form for the use of African nightcrawler earthworm fertilizer.
4. Skill measurement form of the use of African nightcrawler earthworm fertilizer.

2.2. Creation and quality of tools

1. Training tools

a. Training handbook for the use of African nightcrawler earthworm fertilizer for environmental conservation for agriculturists.
b. Study preliminary information by taking information obtained from fieldwork, surveying activity sites, and studying concepts, theories, documents, and relevant research.
c. Set the scope and content structure of the handbook in accordance with the conceptual framework of the study.
d. Create a training handbook for agriculturists on the use of African nightcrawler earthworm fertilizer for environmental conservation. The contents of the handbook contain information about earthworm raising.
e. Take the created training handbook to consult with advisors, then submit five experts to check the quality of the tools by finding the content validity, considering the consistency, suitability of the handbook, and the coverage of the activities. Then, the researcher recorded the results of each expert's consideration on each topic and assessed the manual's suitability using a 5-point estimating scale questionnaire: the most appropriate, high, moderate, low, and the least appropriate, respectively.

2. Measurement and evaluation tools

a. Pre-test and post-test of a knowledge test on the use of African nightcrawler earthworm fertilizer both before and after the activity.

- Study basic information from textbooks, documents, and relevant research as a guideline for creating a knowledge questionnaire.
- Use the data to create a knowledge test. It is a closed-ended question with two options, namely yes and no. A correct answer gets one point, and a wrong answer gets zero. Consisting of 50 items on a rating scale, which is a form of answer determination divided into five levels: excellent, good, average, below average, and unacceptable.
- Bring the created knowledge test to the advisor for consideration and then make improvements according to the recommendations.
- Take the knowledge test on the use of African nightcrawler earthworm fertilizer for five experts to consider its suitability, accuracy, and comprehensiveness and check for content validity. The researcher then recorded the results of each expert's consideration of each topic.
- Improve the knowledge test after receiving experts' advice.
- Take the quiz and try it out with the people who live in Ban Han, Moo 4, Kwao sub-district, Muang district, Maha Sarakham province, which those people were not a sample group of 30 people, to find the reliability of the whole version.

b. Attitude measurement is the use of African nightcrawler earthworm fertilizer for environmental conservation.

- Study basic information from textbooks, documents, and relevant research as a guideline for creating an attitude measurement form.
- Use the data to create an attitude measurement form. It was a closed question with a rating scale, which is a type of response divided into five levels: strongly agree, agree, not sure, disagree, and strongly disagree, a total of 30 items.
- Take an attitude measurement form for five experts to consider suitability, accuracy, and comprehensiveness and check for content validity. The researcher then recorded the results of each expert's consideration of each topic.
- Complete the attitude measurement form after receiving expert advice.
- Take the quiz and try it out with the people who live in Ban Han, Kwao Subdistrict, Muang District, Maha Sarakham Province, which is not a non-sample group of thirty people to find the reliability of the whole version and discrimination power according to Cronbach's alpha.

c. Skill measurement form of the use of African nightcrawler earthworm fertilizer for environmental conservation.

- Study basic information from textbooks, documents, and relevant research as a guideline for creating a participation questionnaire form.
- The data was used to develop a skills measurement form consisting of closed questions. This form employs a rating scale with five levels of response: regularly practiced, often practiced, sometimes practiced, rarely practiced, and not practiced, covering a total of 30 items.
- Take a skills measurement form for 5 experts to consider the suitability, accuracy, and comprehensiveness and check for content validity. The researcher then recorded the results of each expert's consideration of each topic.
- Complete the skills measurement form after receiving expert advice.
- Take the quiz and try it out with the people who live in Ban Han, Kwao Subdistrict, Muang District, Maha Sarakham Province, which is not a non-sample group of thirty people to find the reliability of the whole version and discrimination power according to Cronbach's alpha.

2.3. Data collection

Phase 1: Survey and study basic information for training

1. Study basic information from textbooks, documents, and relevant research as a guideline for choosing an event location.
2. Go to the actual area to survey whether the location is suitable for organizing activities.

3. Take the information obtained with photos of the place where the activities will be held to consult with the advisor.
4. Summarize the results according to the recommendation of the advisor, which is the place for organizing the activities: the Environmental Education Foundation, Nong Pling Sub-district, Muang district, Maha Sarakham province.

Phase 2: Training Design

1. Determine the content and objectives of the activities in order to have a clear pattern and be consistent with the survey results.
2. Prepare an activity manual, which is a training manual to promote the use of African nightcrawler earthworm fertilizer for environmental conservation for farmers.
3. The activity format is set to include a 3-day training with both theoretical and practical lectures.

Phase 3: Training

The training program lasted three days and was conducted at the Environmental Education Foundation in Nong Pling Subdistrict, Muang District, Maha Sarakham Province. The sample consisted of 30 volunteers from Ban Han, Moo 4, Kwao Sub-district, Muang District, Maha Sarakham Province. The training was organized in the following steps:

1. Leading to the training step

- This step was to prepare the trainees or create an atmosphere conducive to the training to familiarize them and reduce the physical and mental stress of the trainees. There are recreational activities and games to relax the participants.

2. Training activities

- Have participants take a test before training, including a knowledge test about raising earthworms, 50 items. Attitude test towards the use of African nightcrawler earthworm fertilizer, 30-item. Training skills test, 30 items.
- Lecture to provide knowledge about the use of African nightcrawler earthworm fertilizer for farmers' environmental conservation for a period of 2 days. Along with testing during the lecture.
- The lecturer joins participants in training on how to make African nightcrawler earthworm fertilizer for a period of 1 day.
- Together, summarize the knowledge gained from the training.
- Have trainees take a test after the training. It is the same questionnaire as before the training.

2.4. Statistics used in research

1. Basic statistics included frequency, percentage, mean, standard deviation
2. The statistics used to analyze the quality of the tools were the index of item objective congruence, difficulty, Discrimination, and Reliability.
3. Statistics used in hypothesis testing were paired t-tests at the statistical significance level of .05.

3. Results

The development of the training manual for using African nightcrawler earthworm fertilizer in environmental conservation yielded the following results. Data analysis indicated an effectiveness level of 88.93/81.07 according to the 80/80 (E1/E2) criteria, with an effectiveness index (EI) of 0.6515 (Tables 1-2). The analysis compared knowledge, attitudes, and skills related to using African nightcrawler earthworm fertilizer for environmental conservation. The results showed that, after the training, participants had significantly higher levels of knowledge, attitudes, and skills regarding the fertilizer's use than they did before the training, with statistical significance at the .05 level (Tables 3-5 and Fig. 1).

Table 1: Effectiveness results for the use of African nightcrawler earthworm fertilizer in environmental conservation based on the 80/80 (E1/E2) criteria

Training manual	Full scores	$\bar{X}$	S.D.	Percentage
Efficiency of process (E_1)	50	44.46	1.40	88.93
Efficiency of product (E_2)	50	40.53	0.77	81.07

Efficiency of training manual (E_1/E_2) = 88.93/81.07

Table 2: EI results for the use of African nightcrawler earthworm fertilizer in environmental conservation

The sum of knowledge scores before training	Total score after training	Number of farmers	Full scores of knowledge (50 X 30)	EI of training manual
685	1,216	50	1,500	0.6515

Table 3: Comparison results of average knowledge scores of the use of African nightcrawler earthworm fertilizer for environmental conservation before and after training by using t-test (paired samples) (n=30)

Items	Before training		Knowledge level	After training		Knowledge level	t	df	p
	$\bar{X}$	S.D.		$\bar{X}$	S.D.				
Knowledge (N = 50)	22.83	1.74	Moderate	40.53	0.78	Maximum	-44.394	29	.000*

*: Statistically significant at the .05 level

Table 4: Comparison results of average attitude scores of the use of African nightcrawler earthworm fertilizer for environmental conservation before and after training by using t-test (paired samples) (n=30)

Items	Before training		Attitude level	After training		Attitude level	t	df	p
	$\bar{X}$	S.D.		$\bar{X}$	S.D.				
Attitude (N = 5)	2.60	0.08	Unsure	4.20	0.09	Agree	-70.587	29	.000*

*: Statistically significant at the .05 level

Table 5: Comparison results of average skill scores of the use of African nightcrawler earthworm fertilizer for environmental conservation before and after training by using t-test (Paired Samples) (n=30)

Items	Before training		Practice level	After training		Practice level	t	df	p
	$\bar{X}$	S.D.		$\bar{X}$	S.D.				
Skill (N = 5)	2.44	0.07	Fair	4.54	0.11	Excellent	-92.741	29	.000*

*: Statistically significant at the .05 level

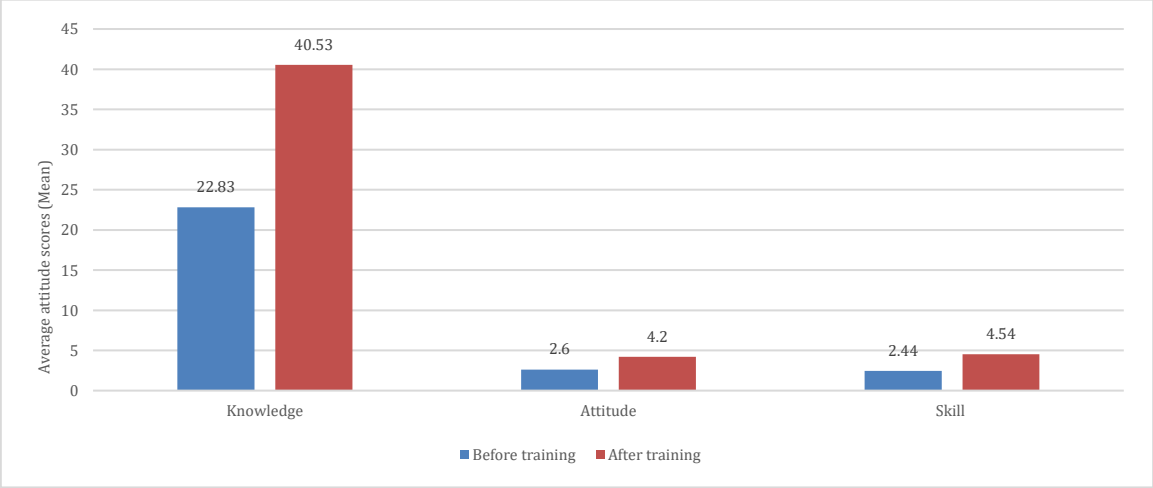

Fig. 1: Chart showing the average scores of knowledge, attitude, and skills of the use of African nightcrawler earthworm fertilizer for environmental conservation before and after training

4. Discussion

4.1. The development of training manual for the use of African nightcrawler earthworm fertilizer for environmental conservation

The results indicated that process efficiency (E1) was 88.93% and outcome efficiency (E2) was 81.07%, showing that the training manual for promoting African nightcrawler earthworm fertilizer achieved an effectiveness level of 88.93/81.07. This meets established criteria, consistent with the concept described by Sitzmann and Weinhardt (2018), who define a manual as a resource written with a specific purpose containing clear, understandable content to guide users efficiently toward their goals. Lanham (2018) similarly described a manual as a document that provides concise guidelines for immediate practical use, enabling readers to achieve their objectives. Additionally, Cerasoli et al. (2018) emphasized that a manual serves as an operational guide, helping users to perform tasks to a standard and reach their intended outcomes. This aligns with findings by Phakeewai and Wongchantra (2020), where environmental camp activities for youth in Roi-Et Province showed an effectiveness of 85.17/83.44 with an effectiveness index of 0.6117. After participating, youths exhibited significantly improved environmental knowledge and attitudes ($p = 0.00$), regardless of gender or residence. Similarly, Somnual et al. (2023) found that an active learning management model effectively developed active citizenship competencies, including knowledge, higher-order thinking skills, and attributes.

The EI of a training handbook designed to promote African nightcrawler earthworm fertilizer use for environmental conservation among agriculturists was found to be 0.6515. This result indicates that the handbook contributed to a 65.15% increase in knowledge, reflecting significant learning progress. According to Salas et al. (2012), effective training materials require a structured framework with clear objectives, specified steps, and defined roles, along with assessment forms and development summaries. To ensure appropriateness, experts evaluated the manual. Aguinis and Kraiger (2009) described training as a vital tool for human resource development, as it builds knowledge, skills, positive attitudes, and behavior changes that drive organizational success and adaptability. Similarly, Hammer (2015) characterized an operations manual as a document detailing each step of a process, including relevant rules and recommendations for improvement. Supporting these ideas, Salas et al. (2012) found that a handbook with an effectiveness rating of 90.86/87.53 and an index of 0.7301 significantly improved students' knowledge and attitudes toward using green products, with learning progress reaching 73.01% and statistical significance at the .05 level. Similarly, Fadli et al. (2022) demonstrated that factors like commitment, discipline, motivation, and creativity in online

learning are essential for achieving educational goals.

4.2. Comparison results of knowledge, attitude and skills of using African nightcrawler earthworm fertilizer for environmental conservation

The average scores for knowledge, attitudes, and practical skills among agriculturists were initially at a moderate level before training and reached the highest level after training. Post-training scores were significantly higher than pre-training scores at the .05 level. This aligns with Bell et al. (2017), who described knowledge acquisition as the first stage of learning, involving initial perception through reading, listening, and remembering. While this step requires minimal cognitive processing, it establishes a foundation for deeper understanding, which then supports further skills like applying knowledge, analyzing, synthesizing, and evaluating new information, and forming connections to future behavior. Baumeister et al. (2007) similarly argued that cognition enables individuals to recognize and recall learned experiences, allowing for the interpretation and expansion of knowledge. Baddeley (1992) emphasized the importance of memory persistence in learning, where recall methods gauge retained information and repeated learning reinforces memory. Blume et al. (2010) described knowledge as an accumulation of experiences and problem-solving abilities, which are triggered by familiar stimuli to guide responses. Additionally, Tejoyuwono and Armyanti (2022) found that early exposure to structured research modules, paired with social and academic support, improved knowledge and positive perceptions, showing that structured learning significantly enhances knowledge and attitudes.

The average attitude scores of farmers regarding the use of African nightcrawler earthworm fertilizer for environmental conservation shifted from an "unsure" level before training to "agreement" after training. This aligns with Baumeister et al. (2007), who described attitude as a combination of knowledge and personal estimation, influenced by feelings and readiness to act based on these feelings. Ajzen (1991) similarly defined attitude as a person's emotional stance, such as liking or disliking, which predisposes them to respond in a certain way. Albarracín et al. (2005) elaborated further, suggesting that attitude comprises a person's beliefs and evaluations, shaping a tendency toward particular actions. In addition, Itasanmi (2019) examined environmental attitudes among market women in Nigeria, noting that while they held positive attitudes toward eco-friendly practices like tree planting, they also exhibited inconsistent behaviors, such as not turning off electrical equipment. These findings highlight the importance of environmental knowledge in shaping attitudes and actions. Sundaram and Ramesh (2022) found that students developed positive attitudes and reflective thinking through engaging, blended learning methods, and Van Tran et al. (2022) observed that training participants showed enhanced attitudes toward the importance of research ethics principles, suggesting that structured learning fosters positive attitude shifts.

The average skill scores for using African nightcrawler earthworm fertilizer in environmental conservation increased from the "seldom practiced" level before training to the "regularly practiced" level after training. This aligns with the concepts discussed by Arthur et al. (2003), who define practical skills as the capacity to perform tasks accurately, flexibly, and efficiently developed through appropriate training. Blume et al. (2010) add that practical skills reflect a person's attitudes, thoughts, and emotions, manifesting as important behaviors that take time to develop. Similarly, Grossman and Salas (2011) described practical skills as behaviors rooted in knowledge and attitudes, which are assessable but develop gradually over time. Supporting these ideas, Haeffner et al. (2012) found that cultivating specific worm strains for biofertilizer production can provide sustainable farming solutions, guiding farmers in crop production for community sustainability. Additionally, Rupavijetra et al. (2022) reported that collaborative, project-based training for students working with older adults led to improved attitudes, behaviors, knowledge, skills, and high satisfaction levels (97.5%). Najib et al. (2020) also noted that students developed high levels of STEM knowledge, skills, and values, demonstrating the effectiveness of structured, skill-focused training.

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Compliance with ethical standards

Ethical considerations

This study adhered to ethical standards with informed consent obtained from all participants, ensuring confidentiality and voluntary participation. Ethical approval was granted by Mahasarakham University.

Conflict of interest

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

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