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Knowledge Management of No-Till Farming in a Highland Area: A Case Study of Farmers in Mae Na Chon Sub-district, Mae Chaem District, Chiang Mai Province

Nathitakarn Phayakka
Department of Agricultural Economy and Development, Faculty of Agriculture, Chiang Mai University, Email: Nathitakarn.p@gmail.com

Anupong Wongchai
Department of Agricultural Economy and Development, Faculty of Agriculture, Chiang Mai University, sidra.raza@umt.edu.pk

Fapailin Chaiwan
Department of Plant and Soil Science, Faculty of Agriculture, Chiang Mai University, sidra.raza@umt.edu.pk

Nobumasa Hatcho
Department of Environmental Management, Faculty of Agriculture, Kindai University, sidra.raza@umt.edu.pk

Shinogi Yoshiyuki
Department of Agro-environmental Science, Faculty of Agriculture, Kyushu University, sidra.raza@umt.edu.pk

Van Van Kim
Department of Aquatic Environment & Diseased, Faculty of Fisheries, Vietnamese National University of Agriculture, sidra.raza@umt.edu.pk

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Abstract

The purpose of this research was to assess the knowledge level of the project participants on no-till farming, both before and after learning about no-till farming. Twenty farmers were recruited to participate in the project in Mae Na Chon Sub-District, Mae Chaem District, Chiang Mai Province. The research process consisted of three steps: (i) planning; (ii) implementation from training, making demonstration plots, monitoring, and evaluation; and (iii) knowledge sharing. In terms of data collection, a qualitative approach is employed using questionnaires, diagrams, log forms, document analysis, and descriptive statistical analysis. The results revealed that, for traditional agricultural production, most farmers

plowed with walk-behind tractors and tractors 1-2 times before planting. After harvesting, the land is often left empty. As for the analysis and assessment of the knowledge level before and after the training and the demonstration plots, it was found that the pre-knowledge level was significantly low (2.04%) while the post-knowledge level improved (4.11%). Besides, at the meeting to exchange knowledge, it was found that there were important issues that should be considered if no-till farming was to be implemented in Mae Na Chon Sub-District and in other highland farming areas. The issues included soil friability, the elimination of regrowing weeds, and pests in the soil. Therefore, the preparation of both the site and the environment should be planned to avoid any potential risk in the soil.

Keywords

No-till farming, knowledge management, highland areas

JEL Classifications: J11, F43

1. Introduction

The highland areas in Thailand cover an area of 67.22 million rai, accounting for 53% of the highlands in 20 provinces, namely Chiang Mai, Chiang Rai, Mae Hong Son, Phayao, Lamphun, Phrae, Nan, Lampang, Tak, Phetchabun, Phitsanulok, Loei, Sukhothai, Kamphaeng Phet, Kanchanaburi, Uthai Thani, Suphan Buri, Ratchaburi, Prachuap Khiri Khan, and Petchburi. Highland Research and Development Institute (Public Organization) defined highland areas as, "mountain areas, areas with a height above sea level of five hundred meters or more, or areas between high-altitude areas as specified by the Board" (HRDI, 2007), or an area with an average slope of more than 35 percent. Most of the highland communities are in the forest upstream, in national parks, and forest reserves causing the government agency to not be able to operate thoroughly. In addition, highland areas still have problems with shifting cultivation and continued deforestation. The complex slope area with a slope of more than 35 percent has not been studied, surveyed, and classified into its types of soil because the area has a high slope which is considered difficult to manage and maintain for agriculture (Department of Land Development, 2020).

In the area of Mae Chaem District, Chiang Mai Province, there is a total area of 2,789 square kilometers or approximately 1,743,282 rai, most areas are high mountains accounting for 70 percent (Sarmiento, 2021), with the largest number of agricultural holdings at 10,468 (7.8 percent) and having the most agricultural holdings at 184,648 rai (15.2 percent), (National Statistical Office, 2013). Maize cultivation took most of the area where the process and procedure of clearing forests and burning stubble which is the impact of smog and is the Hotspots area that accumulated heat (1 Feb.-26 Mar. 2015) as high as 301 points, the second most after Omkoi District, Chiang Mai Province (Kasatpibal et al., 2022) Therefore, it is a problem that the government needs to brainstorm and cooperate with relevant agencies including university departments to participate in research and

find solutions to such problems.

No-till farming is a concept of Fukuoka Masanobu to plant crops. It is a natural way of farming, or a concept of organic farming based on 4 principles: no soil tilling, no scientific fertilizers, no weeding, and no chemicals and pesticides. In addition, no-till farming is suitable for highland crops since machinery such as tractors cannot be used because the area has a high slope and the production cost is not worth the investment. Therefore, the research team realized that knowledge about growing crops using no-till farming methods may be a promising solution and should be encouraged. Hence, knowledge regarding no-till farming is important and should be promoted so that farmers can find a sustainable solution to the problem.

2. Research Objectives

1. To assess the level of knowledge of the project participants about no-till farming, both before and after training.
2. To study the knowledge about the no-till farming method of farmers in Mae Na Chon Sub-District, Mae Chaem District, Chiang Mai Province.

3. Theoretical Framework

The research team used knowledge management tools to extract knowledge from farmers who had received knowledge transfer and participated in meetings to exchange knowledge among farmers, agricultural scholars, and the research team to review and verify the facts of the knowledge using knowledge management tools. This leads to a body of knowledge about growing plants without tilling – in Mae Na Chon Sub-District, Mae Chaem District, Chiang Mai Province – to pass to other farmers in nearby areas or to be an important role model as in the research conceptual framework in Figure 1.

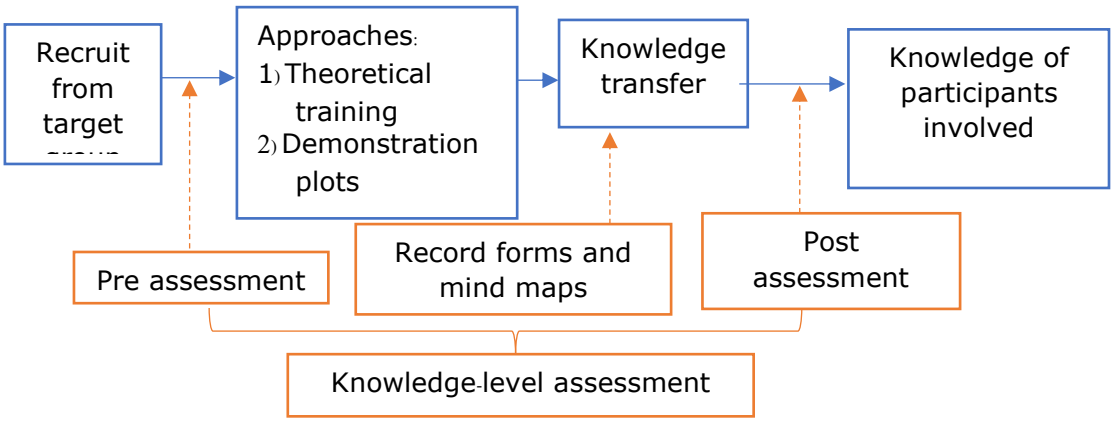

Figure 1 Knowledge Process

4. Materials and Methods

4.1 Experimental Site Descriptions

Study area: Mae Na Chon Village, Mae Chaem District, Chiang Mai Province, with a population of 11,268 (Mae Na Chon Subdistrict Administrative Organization, 2021). The team recruited 20 participants, representing 0.17% of the population.

4.2 Experimental Design and Management

This research is action research focusing on knowledge management in no-till farming in Mae Na Chon Subdistrict, Mae Chaem District, Chiang Mai Province. The method for conducting research according to the framework of the knowledge management process (KM Process) can be divided into three steps as follows:

Step 1: Planning. The team recruited farmers through coordination with relevant agencies, including government agencies and educational institutions interested in attending training in no-till farming. There were also general interviews regarding social and economic characteristics that were statistically analyzed and used as a guideline for the transfer of appropriate knowledge.

Step 2: Implementation from training, demonstration plots, monitoring, and evaluation. This research used knowledge assessment methods (before-after training).

Step 3: Sharing knowledge. The team organized meetings and group discussions, observed, and took notes.

4.3 Measurement

1) Distributing a 5-point Likert-scale questionnaire on no-till farming before and after receiving the knowledge transfer training and making demonstration plots. The assessment points are as follows:

4.51 – 5.00 means the highest level of knowledge
3.51 – 4.50 means a high level of knowledge
2.51 – 3.50 means a medium level of knowledge
1.51 – 2.50 means a low level of knowledge
0.51 – 1.50 means the lowest level of knowledge.

2) Field record forms and mind maps are used for recording and observing the process of knowledge transfer, agricultural experience, and the limitations that arose in agricultural practices or no-till farming in Mae Na Chon Subdistrict, Mae Chaem District, Chiang Mai Province.

5. Statistical Analysis

Researcher team used an inductive method to analyze the data, including interpretations of relevant documents, observations, and interviews.

6. Results and Discussions

6.1 Traditional Agricultural Techniques

The study of traditional crop production methods and systems of farmers participating in the project revealed that the cultivated crops were sold wholesale in the Muang Mai market (vegetables) and to middlemen and seed companies (maize). Before planting, most farmers plowed with walk-behind tractors and tractors 1-2 times. The two most popular methods farmers usually used were sowing in seed holes and sowing in rows. Some farmers did not apply both chemical fertilizers and organic fertilizers, or if they did, it would be in small quantities because farmers knew that if they didn't apply it, they would get the same quantities of vegetables as when they did. As for fertilizing, farmers generally used chemical fertilizers rather than organic fertilizers because they were easy and convenient to buy. Besides, herbicides were commonly used when there was a high infestation, such as cutworms, diamond-back moths, thrips, egg-plant fruit borers, mealy bugs, and beet armyworms. At times, farmers allowed natural pests to spread without eradication or control and did not nourish the soil in any way. After harvesting, the land was often left empty (Figure 2).

Research on farmers who used traditional agricultural production found that there were very few farmers interested in participating in the project, or only 20 participants, representing 0.17% of the area of Mae Na Chon Subdistrict. Most of them worked as farmers, had an average age of 61 years, and were male (75%). Most of them graduated from primary school, accounting for 75%, and had experience in farming (cultivation of vegetable crops and maize) for an average of 31 years, which is consistent with the research of Chadaporn Promphao and colleagues (2020) whose research represented factors related to the health of farmers in Hang Dong District. It was found that, in terms of gender, age, education, and experience, the farmers were similar. Most of the farmers were male; the average age was 58.36 years old; they had primary education, and they had an average rice cultivation experience of 34.50 years. Therefore, this is a reason the research team used to improve the media that will be used to convey the body of knowledge to create awareness and future acceptance.

6.2 Knowledge Management for Farmers

The knowledge management process was used to help identify which tools to effectively transfer knowledge to the target group. Before and after learning, knowledge-level questionnaires were used to assess the knowledge levels of the participants who had passed through training activities and demonstration plots of no-till farming. The questionnaires asked about the issues of knowledge in 2 parts which were implementation in planting plots and the benefits of no-till farming. The research found that before participating in the project, the mean was at a low level (2.04), and the mean of knowledge regarding planting cover crops in the dry season and about the water-holding capacity of the soil was at the lowest level (1.50). As for other knowledge issues, they were at a low level of knowledge.

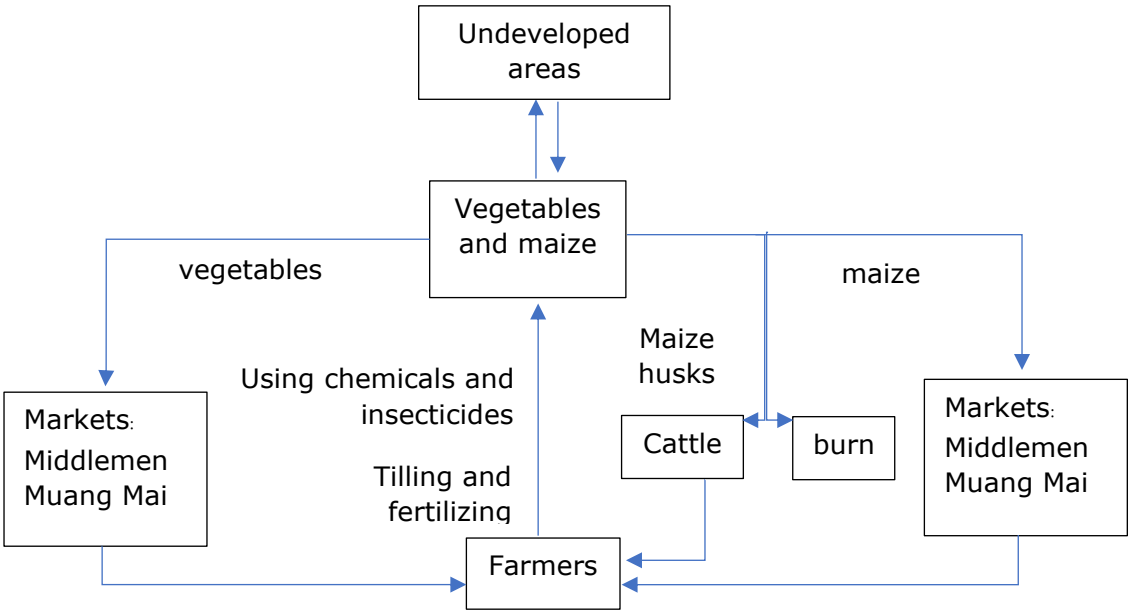

Figure. 2. Flow Diagram of the Practice of Tradition Agricultural in Highland Area

The level of knowledge after joining the project had a total mean of 4.11, or a high level. The knowledge issue on how to make composted manure had an average of 4.75, the highest level of knowledge, followed by the method of soil preparation (using compost and lime) with an average of 4.60, the highest level of knowledge and the reduction in production costs (labor, fuel, and tractor wear costs) was at 4.55, the highest level of knowledge. As for other knowledge issues, they were at a high level except for the issue of cover crops in the dry season with an average of 3.25, a moderate level.

Knowledge	Points Before training	Result	Points After training	Result
1. Prepping fields for crop production				
1.1 The method of soil preparation (using compost and lime)	2.50	low	4.60	highest
1.2 How to plant seedlings or seeds before transplanting	2.45	low	3.80	high
1.3 How to make composted manure	1.85	low	4.75	highest
1.4 Cover crops in dry seasons	1.50	lowest	3.25	medium
2. The benefits of no-till farming				
2.1 Reduction in production costs (labor costs, fuel costs, tractor wear cost)	2.15	low	4.55	highest
2.2 Reduction in pesticides and other chemicals	2.10	low	4.25	high
2.3 The water-holding capacity of the soil	1.55	lowest	3.55	high
2.4 Increase in soil organic matter	2.20	low	4.15	high
Overall Average	**2.04**	**low**	**4.11**	**high**

Therefore, it can be seen that the knowledge level increased from a low level to a high level, meaning that the knowledge transfer process has been successful. The purpose was to increase the level of knowledge to a higher level (a mean score of 3.51 or more), (Kumar et al., 2021), about the project evaluation of the performance of the Nong Bua Lamphu way of organic agriculture promotion project according to the principles of "The King's Philosophy." Regarding knowledge and understanding of organic farming and its utilization, it was found that before participating in the project, the farmers had a moderate level of knowledge. However, after participating in the training, farmers had the highest level of knowledge and understanding.

Interested farmers in Mae Na Chon Sub-District, Mae Chaem District were recruited to join the project where the knowledgeable specialists passed on knowledge to the target group. The lecturers were knowledgeable and specialized in no-till farming. From an assessment before learning, for those who knew about traditional agricultural farming, the results showed that they had a low level of knowledge. Thus, there was a meeting to tailor approaches that could effectively transfer the knowledge to them. The first medium was theoretical training. The content consisted of the knowledge that was measured by the knowledge level from the questionnaire (Table 1). Secondly, the demonstration plots were used with a plan for planting vegetables and implementing them in 3 months, with the start of the soil preparation process using composted manure and lime but without a tractor to plow. Later, seedlings or seeds were planted before transplanting, along with follow-ups by the project participants and the research team. The consultation given to the farmers included pest prevention and elimination, harvesting, and postharvest management.

The knowledge gained from the implementation of the knowledge management framework (KM Process) led to the method of no-till farming, where its focus was different from the general tillage planting, as the preparation of the area and weeding were done using the following methods:

1) Land preparation or soil preparation for cultivation: this starts with cutting or removing grass and weeds, leaving the cut grass on the ground, and then shoveling the soil with a hoe making a hole of 30x30 cm.

2) Sowing in rows: before sowing, soak seeds in warm water for 1 night to stimulate their germination.

3) Cultivation: sow 2-3 seeds per hole (large seeds such as legumes, melons, maize, etc.) at a depth of no more than 1 cm., and cover the hole a little, then add 1 tablespoon of manure that has been composted or used in combination with chemical fertilizers such as 15-15-15 formula near the seed holes to help accelerate early growth and increase yields. The 15-15-15 formula fertilizer contains 15% N nitrogen, 15% P2O5 phosphorus, and 15% K2O potassium.

4) For vegetable seeds that are small and quite expensive, they should be planted in a seedling tray. After they germinate, move them and then manure that

has been composted or used in combination with chemical fertilizers is applied, the same way as done in 3).

5) Dried corn husks, or agricultural waste materials, are used to cover the holes or around the seedlings to maintain soil moisture.

6) Weeding is done 2-3 times during the first 1-2 months for short-lived vegetables (e.g., Chinese cabbages, Guangdong, kales, etc.) while for vegetables aged 1 year or more (e.g., mimosa, ginger, galangal, lemongrass, etc.) weeding is carried out 2-3 times during the first 3-4 months.

The above practice, in addition to being a practical method that can produce agricultural products, could also save the cost of land preparation by using tractors or walk-behind tractors. This also contributed to other positive indirect impacts of reducing air pollution caused by the burning of agricultural waste from stubble and maize husks in the areas.

7. Limitations of No-Till Farming

Farmers participating in the project were well aware of the methods and benefits of no-till farming as this has a beneficial effect on reducing soil erosion which is consistent with the research of (Teresa et al., 2022) whose research was about the effect of till and no-till system on culturable fungal communities in the rhizosphere and soil of two spelled cultivars and fungi, and also in line with the research of Subhajati (2020) studying Plant Growth Promoting Rhizobacteria: Principles and Utilization. The research found that bacteria and fungi play an important role in plant growth: 1) the volume on the root surface of the plant is easily increased, 2) it controls plant pathogenic microorganisms, and 3) it is resistant to dehydration, salinity, heat, and ultraviolet radiation. When the project was implemented in the demonstration plots and knowledge was exchanged between farmers, the researchers observed the problems and obstacles. Therefore, the limitations are as follows:

7.1 Soil Friability

At times, the use of no-till farming or planning crops that do not need tilling can be misunderstood. Tillage still has advantages in improving the structure of the soil by increasing the gap area for the roots positively affecting the plants' absorption as well. This means that the soil becomes dense due to its structure and properties and that it is too packed down. Therefore, no-till farming cannot be used totally for agricultural production, and it is consistent with the research of (Jiaqi et al., 2021) whose study was "Comprehensive benefit evaluation of conservation tillage based on BP neural network in the Loess Plateau." The paper revealed that conservation tillage (except NT or No tillage, no sundry cover) substantially improved soil quality relative to conventional tillage and the NT soil bulk density was significantly higher than those of the other tillage systems ($p < 0.01$).

7.2 The Elimination of Regrowing Weeds

Although one of the advantages of not tilling is cost savings in soil preparation, farmers still need to get rid of weeds. Tilling is still important if farmers do not want to use pesticides. As (Anil et al., 2021) said, "tillage affects weeds by uprooting, dismembering, and burying them deep enough to prevent emergence, by changing the soil environment and so promoting or inhibiting the weeds' germination and establishing, and by moving their seeds both vertically and horizontally."

7.3 Pests in the Soil

Tilling soil can help reduce pests and weeds in soil, and this is consistent with what (Andrei et al., 2019) said in their paper: Soil conservation practices for insect pest management in highly disturbed agroecosystems. The paper revealed that tillage practices had positive or negative effects on pest and insect populations in cotton depending on species and on whether the fields were irrigated or dryland. The direct effects of insect pest populations on cotton are influenced by abiotic and biotic factors which can be created or corrected by conventional or conservation tillage systems.

Therefore, for the transfer of knowledge of no-till farming, the research team had to consider other cases where other factors are involved so that the team could accurately and thoroughly explain the information to the recipients. During the process of exchanging information with farmers, the team found that while farmers had direct experience and knew the problems and the limitations, they only had tacit knowledge regarding the matter. Therefore, the researcher had to come up with a method or process of managing the body of knowledge that is a medium to precisely extract the information from the farmers, and this could potentially be a model to use in the future.

8. Conclusion

From conducting a research project to study the knowledge management of no-till farming by studying traditional agricultural farming in Mae Na Chon Sub-District, where vegetables and maize are grown, the research team found that farmers managed their farms using walk-behind tractors and tractors to prepare the area and using chemical fertilizers rather than organic fertilizers. Even though farmers commonly employed chemicals to get rid of insects and pests, they sometimes left pests to infest naturally without elimination or control and no soil nourishment. After harvesting, the land was often left empty. The produce was sold wholesale in the Muang Mai market (vegetables), and to middlemen and seed companies (maize).

In terms of knowledge management, knowledge level assessments were carried out (before and after the training), and it was found that the level of

knowledge before training and making demonstration plots was low. Nevertheless, after the training and making demonstration plots, the level became high showing that the knowledge transfer process has been successful. The research team, therefore, held a meeting to exchange knowledge in order to comply with the conceptual framework. As a result, it was found that such transmission still had various limitations, such as soil friability, the elimination of regrowing weeds, and pests in the soil, so the project participants, academic departments, and research teams should consider those limitations when applying the knowledge to practice.

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