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ADOPTION OF VERMICULTURE TECHNOLOGY AMONG SUSTAINABLE ECOLOGICAL AGRICULTURE PRACTITIONERS IN PALMA AREA

ROY A CABATAC* AND NEYRMA N CABATAC

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ABSTRACT

The study was conducted to develop a model for the adopters of Vermiculture Technology among the SEA Practitioners in PALMA Area. Data were gathered through interview using a structured questionnaire.

The data show that except for some technical aspects like tossing of the vermibeds, drying animal manure and using plastic, most of the aspects were either very strongly or strongly adopted by the respondents.The most common factors that influence them to adopt the technology were as follows: potential source of income, availability of materials, reduction of volume waste, and ease of practice and management. A decision-model was developed from the characteristics/profile of the respondents and their extent of adoption of the technology. The model can be used to determine the level of adoption of would-be adopters of the vermiculture technology.

Keywords: Virmiculture Technology, SEA Practitioners, decision-model

1. INTRODUCTION

Vermiculture technology is the science of cultivating earthworms which feed on organic waste and release back into the soil digested food material, thereby producing nutrient-rich compost called vermicast. Vermiculture technology as an innovation has become an important tool in waste recycling all over the world. Essentially, the vermiculture provides for the use of earthworms as natural bioreactors for cost-effective and environmentally sound waste management (Kale 1998). According to Kale (1998), exploitation of vermiculture biotechnology has potential in stopping ecological degradation and providing nutritional needs to the agricultural sector.It helps to avoid environmental pollution including the expenditure of resources to treat organic waste (Singh et al., 2004).

In developing countries like the Philippines, vermiculture technology may prove helpful especially among farmers as they can benefit from the composting of farm wastes such as rice straw and other plant debris, kitchen scraps, and even animal manure. These wastes, according to Ismail et al., (2003), are misplaced valuable resources that can be utilized by proper composting.Besides, the application of vermicast has been proven effective in increasing production and productivity of different crops (Singh et al., 2004).

The large volume of organic wastes generated through agricultural activities, the high cost of fertilizers, the increasing demand for organic food, the need to increase farm production and the alarming issue of climate change call for the promotion and use of vermiculture technology. It is in this milieu that the technology was introduced to the Sustainable Ecological Agriculture (SEA) Practitioners.

Sustainable Ecological Agriculture (SEA) is an initiative of the Community Education Research and Extension Administration of Southern Christian College, a private educational institution. SEA is an agricultural method that operates based on the following principles: selection of location or site-specific species and varieties, crop and livestock diversification, recognition of cultural practices that enhance economic stability, management of soil to improve quality, drawing on efficient and human-use renewable inputs; and consideration of farmers' goals and lifestyle choice (CARRDEC, 2007). SEA rules out burning of farm residues and other organic matter, monocropping and the use of chemical inputs. In sum, SEA is a kind of agriculture that integrates environmental health, economic profitability, and social equity.

In 2007, vermiculture technology was introduced to 30 SEA practitioners in PALMA Area through in-house training. The participants of the said training were provided with vermin as initial stock. The technology is simple and can be easily learned. Except for the vermin, the raw materials are generally obtainable in the farm. In technology transfer, the aim is for the farmers to adopt the technology and bring it to practice for further diffusion into the community (Chi & Yamada, 2002). Oftentimes, there is positive feedback to an introduced technology, yet it cannot be denied that farmers also encounter difficulties in its application. There is always that struggle of putting training recommendations into practice, hence affecting the adoption of the technology. This study was undertaken to develop a decision model

Faculty-College of Arts and Sciences, Southern Christian College, Midsayap, Cotabato, Philippines
*Corresponding authors email-
roy.cabatac@southernchristiancollege.edu.ph

on the adoption of vermiculture technology among the SEA practitioners of the Pigcawayan, Alamada, Libungan, Midsayap, Aleosan (PALMA) Area. The model will likely give insight and understanding on the adoption of a technology.

2. STATEMENT OF THE PROBLEM

The main objective of this study was to develop a decision model on the adoption of the Vermiculture Technology. Specifically, this study aimed to determine the 1) characteristics/profile of the SEA practitioners; 2) their extent of adoption of the vermiculture technology concerning (a) bed preparation and management, (b) raw materials and (c) harvesting of vermicast and vermin; 3) the factors that influenced their adoption of the technology; and 4) the innovations made on the technology.

3. FRAMEWORK

Scope and Limitations

This study is focused on developing a decision model in the adoption of the vermiculture technology. Only the SEA practitioners who ventured into vermiculture technology were considered respondents of the study.

Conceptual Framework

Technologies play an important role in economic development (Abera, 2008). According to Abera (2008), adoption of any innovation would take time to complete, and adopters may continue or cease to use a technology.The duration of adoption of a technology varies among economic units, regions and attributes of the technology itself (Abera, 2008).

Abera (2008) defines adoption as the decision to use a new technology or practice, while Rogers (1983) defines it as the use or non-use of a new technology by a farmer at a given period. This definition can be extended to all economic units in the social system. In the adoption of a technology, there could be individual adoption and aggregate adoption (Feder et al., 1985). This study on the adoption of vermiculture technology focuses on what Feder et al. calls as individual or farm-level adoption.

Adoption decision involves numerous factors such as resources, area allocations, ease of management, and so on. Thus, the process of adoption includes the simultaneous choice of whether to adopt a technology and the intensity of its use (Abera, 2008). Several interdependent decisions are made before a farmer considers adoption of a technology (Hassan, 1996 in Abera, 2008).

Sevilleja (n.d.) states that studies on factors influencing adoption technology have economic and social underpinnings. He further mentions that economic and technical factors inherent in alternative technologies and the individual's sociological characteristics may influence farmer decision-making processes. The rate of adoption may also depend on variables such as profitability or relative advantage and compatibility (Rogers, 1983). Other factors such as capital, credit availability, experience and education, risk aversion, and supply of supplementary inputs are cited by Feder et al. (1985).

Singh et al. (2008) have shown adoption gap in vermiculture technology. The gap was attributed to farmers' poor knowledge and lack of skills. However, Sevilleja (n.d.) explains that adoption of innovation or introduced technology can be facilitated only if the perspective of the farmers is considered.Hence, technology adoption is influenced not only by the characteristic of the technology but also by human element. The decision of use of a technology is dependent on how farmers perceive the technology and the change agent such as extension worker, professional, etc. (Chi & Yamada, 2002).

Technology reaches farmers via technology transfer or the general process of moving information and skills from knowledge generators (Valera et al., 1987). The outcome of such transfer according to Yamada and Chi (2002) is the adoption of technology. In the adoption of a technology, Valera (1987) mentioned that farmers discover problems in putting recommendation into practice. Thus, this study stands on the innovation decision model by Rogers (1983) where an individual, after gaining knowledge on a technology, develops an attitude towards it then to a decision to adopt or reject it.

4. METHOD

Locale

This study was conducted in the PALMA area. PALMA is an alliance of five municipalities in North Cotabato, namely, Pigcawayan, Alamada, Libungan, Midsayap and Aleosan.

Research Design

This study employed the descriptive research design to describe the profile of the respondents, their extent of adoption of the technology, the factors that influenced their adoption and the innovations they made, and to illustrate their decision on the adoption of vermiculture technology.

Sampling Plan and Respondents

The study used non-probability sampling plan. There was no random selection of samples. Rather, the main respondents were identified based on their adoption of the vermiculture technology. There were 30 respondents in this study. They are Sustainable Ecological Agriculture (SEA) practitioners from the PALMA Area.

Research Instrument

An interview schedule was used to gather data from the respondents. The structured questionnaire was composed of two (2) parts. Part 1 asked about the profile of the respondents and Part 2 asked about their adoption of the vermiculture technology. The scale and the interpretation of the responses in the second part of the instrument are as follows: 5 for very strongly adopted, 4 for strongly adopted, 3 for moderately adopted, 2 for occasionally adopted and 1 for not at all adopted. The interview guide was used to further get information on the adoption and practice of the technology.

Data Gathering Procedure

Data were collected from the respondents using the structured survey instrument. The instrument was personally administered by the researcher. As soon as respondents have answered the questionnaire, interviews were done to gather additional information on the adoption and practices of the technology.

Analysis of Data

The extent of adoption of vermiculture technology and the profile of the respondents were processed and analyzed using frequency, percentages, t-test and ANOVA. Data taken using the interview guide were analyzed using content analysis.

5. FINDINGS

Characteristics/Profile of the Adopters of Vermiculture Technology

Demographic Profile. The subsequent tables show the characteristics/profile of the SEA Practitioners in PALMA area who are adopters of the Vermiculture Technology. Table 1 shows their profile as to age, sex, residence and educational attainment.

Table 1 Characteristics/Profile of the adopters of Vermiculture Technology among the SEA practitioners in PALMA Area

Characteristics of Adopters	Categories	Frequency (f)	Percentage (%)
Age	21-30	4	13.3
	31-40	1	3.3
	41-50	8	26.7
	51-60	8	26.7
	61-70	5	16.7
	71-80	4	13.3
Sex	Male	19	63.3
	Female	11	36.7
Residence	Pigcawayan	7	23.3
	Alamada	4	13.3
	Libungan	4	13.3
	Midsayap	12	40
	Aleosan	3	10
Educational Attainment	Elementary Graduate	1	3.3
	High School Level	2	6.7
	High School Graduate	7	23.3
	College Level	9	30
	College Graduate	11	36.7

<u>Age.</u> The grouped frequency distribution has shown that most of the adopters (26.7%) had ages ranging from 41-50 and 51-60, 16.7% had ages ranging from 61-70, 13.3% had ages ranging from 21-30 and 71-80, and only 3.3% were in the age range 31-40 (*see Table 1*).

<u>Sex.</u> Regarding sex, majority (63.3%) of the adopters are male while 36.7% are female. It shows that there were more male adopters than female adopters who participated in the study (*see Table 1*).

<u>Residence.</u> The largest group of adopters was from Midsayap and constitutes 12, comprising 40% of the total. The smallest group comes from Aleosan with 3 respondents comprising 20% of the total (*see Table 1*).

<u>Educational Attainment</u>**.**As to educational attainment, the highest percentage of adopters graduated in college (36.7%), while the least were elementary graduates comprising 3.3%. This means that most of the adopters have earned their college degrees. (*see Table 1*)

The Farm and Farming Condition. This section shows the farm and farming condition of the adopters of vermiculture technology. Data on these were taken since the initial aim for their participation in the vermiculture training was to help them address the need to produce vermicompost for their own farms. Data taken for this aspect included the total land area being farmed, the farming condition, and the monthly income derived from their farms.

<u>Total Land Area Being Farmed.</u> Table 2 below shows the grouped frequency distribution of the adopters in relation to the total area farmed. It can be noted that 18 of the adopters have farmlands not exceeding 2 hectares. They comprise 60% or more than one-half of the respondents. The smallest groups comprising 1 respondent (3.3%) each has farmlands ranging from 6.01 to 8 and 8.01 to 10 hectares. The data indicate that most of the adopters are small landholders, and the mean farm area is 2.57 hectares.

Table 2 Frequency and percentage distribution of the adopters based on total land area farmed

Farm Area (Ha)	Frequency (f)	Percentage (%)
Less than 2	18	60
2.01 to 4	8	26.7
4.01 to 6	2	6.7
6.01 to 8	1	3.3
8.01 to 10	1	3.3

<u>Farming Condition.</u> Table 3 below shows that 19 of the adopters have lowland irrigated farms. They comprise 63.30% of the respondents. This is followed by the adopters with upland farming condition (26.70%) and those with lowland non-irrigated farms (*see Table 3*).

Table 3 Frequency and percentage distribution of the adopters according to their farming condition

Farming Condition	Frequency (f)	Percentage (%)
Lowland Irrigated	19	63.30
Lowland non-irrigated	3	10.00
Upland	8	26.70

Farm Monthly Income. The farm monthly income of adopters is shown in Table 4. Forty percent of them have farm income that ranges from P5,001.00-P10,000.00, 30% have income not more than P5,001.00, 16.7% have income ranging from P10,001.00-P15,000.00, and 13.3% have a monthly income ranging from P15,001 to P20,000.00.

Table 4 Frequency and percentage distribution of the adopters according to their farm monthly income

Monthly Income (in Pesos)	Frequency (f)	Percentage (%)
Less than 5,001.00	9	30.00
5,001.00-10,000.00	12	40.00
10,001.00-15,000.00	5	16.70
15,001.00-20,000.00	4	13.30

Extent of Adoption of Vermiculture Technology

This section presents the data on the extent of adoption of Vermiculture Technology as to bed preparation, management, raw materials, and harvesting of vermin and vermicast.

Bed Preparation. Bedding provides a stable habitat for worm production. There were six items for bed preparation that were included in the training recommendations. The respondents of this study were asked to determine whether each item was very strongly adopted, strongly adopted, moderately adopted, occasionally adopted and not at all adopted. Table 6 shows that of the nine items, setting up their vermibeds near water source but not in flooded areas was very strongly adopted. This was followed by placing a thick layer of earthworm on one side of the bed. The respondents likewise strongly adopted the use of raised vermibeds with 2 inches agricultural wastes and the use of windrows and shaded beds. They also strongly adopted the recommendation of preparing the beds before treatment. Of the nine items, they occasionally adopted the use of neem leaves for bed treatment. Moisture is the most important requirement, since the worms should have at least 60-70% moisture. Flooded areas are not recommended to prevent anaerobic conditions in the beds (Garg et al., n.d). Adoption of technology entails risks. The results have shown that the most crucial factors affecting the production of vermicast were strongly given attention in the preparation of beds. As to the use of neem leaves for bed treatment, this study revealed that the adopters used Madre de Cacao (*Kakawate*) as alternative.

Table 5 Extent of adoption of vermiculture technology as to bed preparation

Item	Mean	Verbal Description
Use of raised vermibeds	3.97	Strongly Adopted
Use of windrows	3.90	Strongly Adopted
Shading of vermibeds	3.83	Strongly Adopted
Vermibeds in flood-free areas	4.47	Very Strongly Adopted
Vermibeds near water source	4.57	Very Strongly Adopted
Beds prepared prior to treatment	3.80	Strongly Adopted
Use of neem leaves for bed treatment	1.43	Occasionally Adopted
Use of 2 inches agricultural waste for beds	3.97	Strongly Adopted
A thick layer of earthworm placed on one side of the bed	4.20	Very Strongly Adopted

Table 6 Table 6. Extent of adoption of vermiculture technology as to management

Item	Mean	Verbal Description
Regular sprinkling of water on beds	4.07	Strongly Adopted
Beds kept moist for 2-3 days	4.03	Strongly Adopted
Use of clean water to moisten the beds	4.40	Very Strongly Adopted
Tossing the beds to loosen and aerate bedding	3.33	Moderately Adopted
Protecting worms from natural predators	4.47	Very Strongly Adopted
Keeping beds from unwanted plants	4.53	Very Strongly Adopted

Management. Good management practices are geared towards the continuous production of worms and vermicompost. Table 6 reveals that a comparatively higher number of respondents very strongly adopted the practice of keeping beds from unwanted plants (4.53), protecting worms from natural predators (4.47) and use of clean water to moisten the beds (4.40). The respondents strongly adopted regular sprinkling of water on bed (4.07) and keeping them moist for 2-3 days (4.03). They moderately adopted the practice of tossing the beds to loosen and aerate beddings. The organic matter making up the beds become suitable material for the growth of unwanted plants. If left to grow, they could easily multiply affecting the quality of the vermicast by utilizing the nutrients, hence the very strong adoption of protecting the beds not only from unwanted plants but also from predators. The common predators, according to them, were chickens and frogs. The results further show that all the items under management were adopted.

Raw Materials. The raw materials influence the composting quality. They could be animal wastes and/or crop wastes, with the former as having higher fertilizer value over the latter (Yang, 1997). Data in Table 7 show that the adopters very strongly adopted the use of crop waste and animal manure as raw materials. They also strongly adopted the chopping and grinding of the raw materials, storage and pre-treatment, use of one part carbon source and three parts nitrogen and drying of both green manures. Drying of animal manure was occasionally adopted. Results show that most of the recommendations as to the raw materials were either very strongly adopted or strongly adopted. This suggests that the adopters considered the quality of the product, either vermicast or vermicompost.

Table 7 Extent of adoption of vermiculture technology as to raw materials

Item	Mean	Verbal Description
Use of 1 part carbon source and 3 parts nitrogen sources	3.73	Strongly Adopted
Use of animal manure	4.60	Very Strongly Adopted
Use of plant/crop waste	4.70	Very Strongly Adopted
Storage and pre-treatment of materials prior to composting	3.77	Strongly Adopted
Drying of green manure prior to storage and composting	3.70	Strongly Adopted
Drying of animal manure prior to composting	2.43	Occasionally Adopted
Chopping and grinding of raw materials to reduce their sizes	4.07	Strongly Adopted

Table 8 Extent of adoption of vermiculture technology as to harvesting of vermicast and vermin

Item	Mean	Verbal Description
Use of side-to-side method (finished compost is moved to one side of the bin and the empty side is filled with fresh bedding)	4.13	Strongly Adopted
Use of bright light and scoop method (bright light is focused on worms so they burrow into the vermicast)	2.67	Moderately Adopted
Use of sun-dried method (the sun will dry the castings; as it does, the worms will move down through the mesh into the moist bedding below)	2.40	Occasionally Adopted
Castings are scooped after migration of worms to fresh bedding	3.93	Strongly Adopted
Top layer of vermicompost is scooped off	3.63	Strongly Adopted
Use of plastic mesh	1.43	Not at all Adopted
Use of gravel screen	3.20	Moderately Adopted

Harvesting of Vermin and Vermicast. Table 8 shows the extent of adoption of harvesting practices of vermicast and vermin. There was an observation that the respondents strongly adopted the use of side-to-side method (4.13) and scooping the castings after the worms have migrated to fresh bedding (3.33). They moderately adopted the use of gravel screen (3.20) and bright light and scoop method (2.67). The use of sun-dried method was occasionally adopted, while the use of plastic mesh was not at all adopted. According to the respondents, it is difficult to harvest using plastic mesh because of the tendency of the cast to stick on mesh. Hence, they prefer the other recommended methods of harvesting. Gravel screen is used mostly by those who have ventured into selling of cast. Those who use the compost for their farms do not consider it practical to use gravel screen to separate the cast from the debris that were not totally decomposed.

Factors influencing Adoption of Vermiculture Technology

This study looked further at the factors considered by the respondents in their adoption of vermiculture technology. The respondents ranked the factors based on the most influential to the least influential. The frequency polygon (Figure 1) shows the respondents' ranking of the factors.

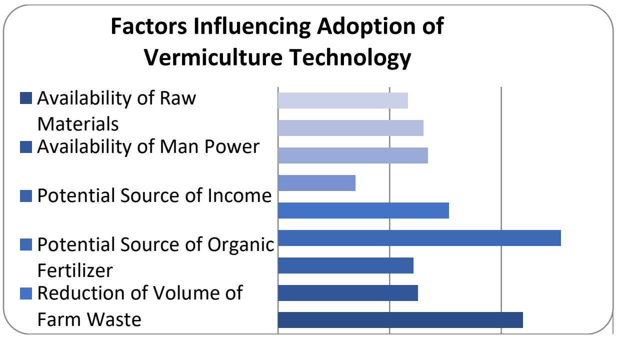

Figure 1 The factors that influenced the adoption of Vermiculture Technology

This study shows that the decision of the adopters of the vermiculture technology to adopt the technology is most influenced by the notion that the technology can provide a potential source of organic fertilizers. The adopters are all engaged in organic farming activities as their livelihood. Since farming would require the use of organic fertilizers, their production through the vermiculture technology could be a prime motivation for their decision to adopt the technology.

The availability of raw materials ranked second as consideration in their adoption. There could be difficulty in the practice of the technology if raw materials are not locally available. The potential of the technology to reduce farm waste is the third factor considered. Both "The Organic Act of 2010" (R.A. 10068) and "The Ecological Solid Waste Management Act" (R.A. 9003) prohibit burning of agricultural waste. Burning of waste is a common practice in the rural areas. With the technology, problems on the disposal of voluminous farm waste can be addressed.

Ease of practice ranked as the fourth factor influencing their decision to adopt. A technology must be simple, which means that it must be easy enough for it to be acceptable (Helberger et al. [Eds.], 2004). The fifth factor is small area requirement. The technology generally does not require a large space and therefore can be potentially adopted by small landholders. As shown in Table 3 majority of the respondents have farmlands less than 2 hectares. The rest of the factors were as follows: availability of manpower, potential source of income, low investment requirement, and availability of market. Since these factors were in the bottom ranks, they offer a view that the technology was not adopted mainly for generating income. It was observed however, that the early adopters or those who have been using the technology for several years have considered it as a source of supplemental income. These adopters made innovations and adjustments on the technology based on their experience and because of obtaining information from other practitioners. This observation is like the findings of Feder et al. (1985) in their survey on the adoption of agricultural innovations in developing countries. This is further supported by Ghadim and Pannell (1999), who said that adoption decision is a dynamic process that involves changes in the farmers' perceptions and attitudes as acquisition of better information progresses and farmers' ability and skill improve in applying new methods.

Decision Model of the Adopters of Vermiculture Technology

This section presents a decision model (Figure 2) of the adopters on the aspects of vermiculture technology. The model shows the constraints or limitations encountered by the respondents because of their decision for non-adoption of some of the aspects of the technology. The model is limited to the items that gained the highest adoption gap. In the extent of adoption, these items gained non-adoption (not at all adopted), occasional adoption (occasionally adopted) and moderate adoption (moderately adopted) responses.

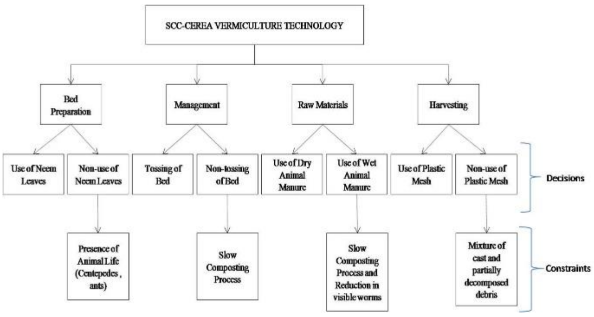

Figure 2 A decision model on the adoption of the aspects of vermiculture technology

As to bed preparation, the use of neem leaves for bed treatment had an adoption gap of 70%. Non-adoption of this aspect was associated with the presence of other animal life in the vermiculture, specifically centipedes, ants, and mites. Neem is a biological control pest agent (Winrock, 1998). In terms of management, tossing of beds gained the highest adoption gap of 23.33%. Tossing of beds permits proper aeration during the composting process. Poor aeration renders anaerobic conditions and results to an increase in temperature which can cause severe mortality to the worms (Singh et al., 2004; Garg et al., n.d.). In a literature review of worms in waste management by the University of South Wales, it was reported that it is very rarely that practitioners of the technology toss worm beds. The report further states that "compaction will result in an absence of oxygen and hence no worm activity". In this study, non-tossing of beds was found to lead to slow composting probably due to the reduced worm activity.

The use of dry animal manure has an adoption gap of 40%. This indicates that there were adopters who did not practice drying of animal manure prior to composting. Instead, they directly placed wet manure on the compost.Use of wet animal manure increases temperature, which can be lethal to the worms. If worms are reduced because of this, the adopters should expect slow composting process.

In harvesting, the use of plastic mesh gained the highest adoption gap of 83.33%. This means that most of the respondents did not adopt this aspect of the technology. The intention for the use of plastic mesh is to produce pure fine vermicast (pure excreta) that is free of any foreign material. Except for some respondents, the harvested vermicompost is used to fertilize their own crops, thus the non-adoption of the plastic mesh. The constraint for its non-adoption is the production of vermicompost, a mixture of vermicast and unprocessed organic matter. Hence, if adopters intend to produce vermicast, it is recommended to use plastic mesh.

Decision-making is vital to any individual. The above model appears simple and linear, but it is an iterative process. The adopter either stops adopting the technology or innovates when confronted with constraints (Figure 3).

This study has shown further that the traininghas provided the respondents with knowledge and basic skills on the use of the technology. Two respondents mentioned that during the training they were shown the step-by-step process of the technology. Systematic training on the use of a technology could help potential adopters to consider it for adoption.

The respondents of this study underwent hands-on or workshop on the technology specifically on bed preparation, management practices, selection of raw materials, and harvesting of vermicast and vermin. During the training, the respondents saw the potential farm benefits of the technology (source of organic fertilizer & reduction of farm waste), it also made them assess the availability of resources (raw materials) in their respective areas. The workshop experience led them to decide that the technology is simple and doable (ease of practice and management). These were reflected in the ranking of factors that influenced their decision to adopt.

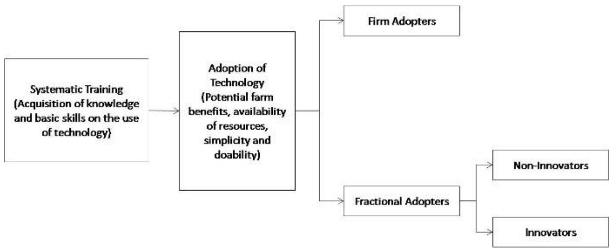

Figure 3 The adoption process of vermiculture technology

The study on their adoption of the technical aspects of the technology, however, has shown that there were no firm adopters of the technology (Figure 4). The data revealed that the respondents are fractional adopters, which means that not all the training recommendations were put into practice, leading to the constraints encountered (by non-innovators) or to further innovation of the technology (by innovators). Innovation on the use of the technology has been observed among early adopters, who later saw the technology as a potential source of income. The innovations employed include the use of permanent bed structure and shading, use of shredder for the raw materials, and separators for harvesting. Innovations can emerge in response to scarcity, economic activities, and environmental regulations for environment-friendly technologies (Sunding and Zilberman, n.d.). Organic agriculture is slowly gaining ground, and this was seen by some respondents as opportunity to venture into increased production of vermicast.

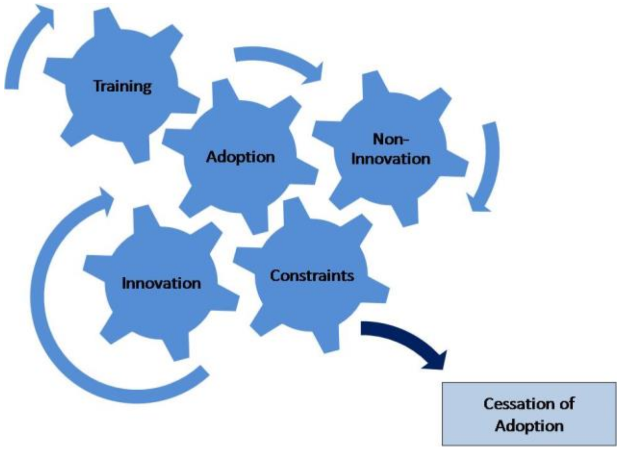

Figure 4 Iterative decision-model on the adoption of Vermiculture Technology

6. CONCLUSIONS

Based on results of the study, the following conclusions were drawn: 1) most of the aspects of vermiculture technology were either strongly adopted or very strongly adopted and there were aspects that were not adopted, 2) the adoption of technology is mainly influenced by the immediate benefit that can be derived for farm application, and 3) the decision-model developed can be used to determine the level of adoption of the would-be adopters of the Vermiculture Technology.

Based on the findings of this study, it is recommended that the developed model be tested and to conduct further research on the decision to adopt to include those who received trainings but did not adopt the technology.

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