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DIFFUSION AS AN INNOVATION: PROMOTING EFFECTIVE MICROORGANISM TECHNOLOGY AMONG HOG PRODUCERS

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Abstract: *This novel study analyses the adoption by hog producers of the Effective Microorganism (EM) technology in the province of Batangas. It has been slow despite the growing evidence of its effectiveness and efficiency in the Philippines and in over 140 countries worldwide. However, there is no common result that can validate the effectiveness of this technology on matters of production output. The researcher focused on three objectives; (1) to identify factors affecting their interest in the diffusion of EM technology as an innovation; and (2) to determine whether significant relationships exist between (a) selected factors such as (i) motivation; (ii) knowledge; (iii) experience; (iv) familiarity and (v) other contextual variables such as demographic profile and farm characteristics and (3) interest to adopt such innovation. Its end objective is to come up with recommendations to expedite the interest to adoption of innovative hog production system highlighting the use of EM technology among backyard hog producers. The study randomly collected 400 backyard hog producers in the cities of Batangas. It was further stratified into 64 respondents in Tanauan, 304 respondents in Laurel and 32 respondents in Talisay through a survey questionnaire. Statistical methods such as frequency count, and correlation were used to evaluate the objectives and the hypothesis identified. The study showed that the hog producers moderately disagree to adopt EM technology. Findings showed that motivation was related to civil status and education. Experience and familiarity were related to gender and interest to adopt was related to married hog producers. Familiarity and experience were related to number of employees. Knowledge (hear and learn) was related to number of employees and farm area (ha).*

Keywords**:** *Diffusion Of An Innovation, Agriculture, Sustainability, Profitability, Microbial Inoculation*

Introduction

EM technology is popular and being used in 140 countries worldwide. Its output is a bio-fertilizer called "Effective Micro-organisms". It is developed by TeruoHiga at the University of Ryukyus, Okinawa, Japan (Higa,1991). EM technology is the "the lifeline of an organic/natural farming" and is very vital in every industry especially organic/natural farming (Costales, 2015). The many beneficial effects on the technical and environmental efficiencies of EM tech are the following: 1) inhibit harmful microbial species; 2) enhance the proliferation of beneficial microorganisms, and 3) detoxify harmful substances simultaneously (Higa, 1993, 2001, 2003).

The global trends in animal agriculture had been affected largely on the changes in lifestyle and eating habits of the people. Consumers are demanding leaner meat and less fat in meat. As a result, competition in the market place continues to drive increased efficiency to livestock production to lower per unit cost to consumer. Additionally, the increasing emphasis on disease prevention rather than treatment is another trend in livestock. Livestock producers can lose approximately 20 percent of their income from disease, parasites, and toxins.The most alarming concern is the increasing large scale and integrated hog production (Frank B. Flanders and James R. Gillespie 2018) 9th edition, Modern Livestock and Poultry Production p.20). In the Philippines, particularly Batangas where backyard hog producer is eliminated and cannot compete with large scale hog producers issue of efficient production is attributed to EM technology.

The main objective of the study is to come up with recommendations to expedite the interest and implementation of innovative hog production system highlighting the use of EM technology among backyard hog producers.

The study filled that gap by determining the different statistically significant factors which promote overall interest (persuasion), growth performance, profitability and nutriently safe and healthy meat products together with a set of exogenous variables(knowledge, motivation, experience, familiarity) and contextual variables such as demographic profile(in terms of age, gender, status and educational attainment), and firm characteristics(in terms of no. of employees, no. of hogs and farm area) highlighting the used of EM technology among 400 hog producers in the Philippines particularly in the of province of Batangas. It aimed to answer the following research objective. What are statistically significant factors for determining the driving factors that expedite the interest and implementation of innovative hog production system using of EM technology among backyard hog producers? To be able to answer the research gap and objective, a descriptive research design was derived using structured survey questionnaires to measure the independent variables among 400 backyard hog producers and quantify the results using 3 statistical tests.

The theoretical implication of the study is that the implementation technology is effectively constant relative to productivity. And that, the main issue and practical implication of the study are dependent on the four determinants particularly described as follows; culture, educational attainment, financial knowledge and technical knowledge. In order to bolster and come up with

a conclusive evidences on both the theoretical and practical implications of the study, a full blown investigation is highly recommended for future research and researchers alike.

Literature Review

The Efficacy Of Em Tech

The efficacy of EM technology can be classified into two main efficiencies: 1.) technical (probiotic) efficiency as food and drink additives, control and reducing foul odor and flies, maintaining the health of livestock and decreasing diseases by improving immune system, improve the quality products (egg, milk, meat) and reduce costs of the waste management composting, and water waste treatment and 2.) environmental efficiency (eliminate foul odor and enhance decomposing of organic matter, can revitalize self-cleaning function of nature in Malaysia and for disaster recovery in Thailand Tsunami in 2005, cleaning lakes and rivers in Thailand and for controlling odor at the relocation site Cagayan de Oro flash flood (Philippine,2014).

The Development of Organic Farming Using Em Technology

Organic hog farming using EM (PROBIOTIC) technology can be viewed as an innovation of Traditional or Conventional hog farming when used and practiced by a farmer. Thus, farmers and customers play a major role in the adoption of this innovation in the agricultural field. There is one biofertilizer called "Effective Micro-organisms" (EM) that is consider to be an "elan" vital in an organic and natural farming(Higa,1991) and has been selected from various environments and described as a combination of more or less 80 "compatible beneficial microorganisms (Higa,1993). Higa suggested a very broad application range of EM preparations and has reported to have beneficial effect in different environment such as soil, plants and water (Higa 1993,2001, 2003). EM preparation are reported to include population of lactic acid bacteria, yeast and small number of phototrophic bacteria, filamentous fungi and Actinomycetes (Higa and Parr, 1995), that may inhibit harmful microbial species, enhance the proliferation of beneficial microorganisms and detoxify harmful substances simultaneously. (Higa,1993,2001,2003).

Reasons For Organic Hog Production Using Em Technology And Its Attributes

The concept of adoption from diffusion of innovations theory helps to frame the problem of organic hog production through use of EM technology as well as organic conversion among traditional farmers of different product sectors. An innovation, like organic farming, is an idea, practice, or object that is perceived as new to potential adopters. The attributes of an innovation—its relative advantage, compatibility, complexity, trialability, and observability—greatly affect its adoption (Tress, 2001; Padel, 2001; Lockeretz& Madden, 1987; Panel, 1999; Howelet et al., 2002; Kaltoft, 1999, Rogers, 1983). Organic farmers of differing product sectors may perceive the attributes of organic farming in diverse ways, which may in turn reflect differences in organic farmers' motives relative to their respective product sector. Through the framework afforded by adoption theory, farmers' perceptions /opinions of organic farming and their motives in adoption and use of EM technology can be compared. (Abdulai& Huffman, 2005; Ajzen, 1980; Conford, 2002)

Global And U.S Farmers' Motives And Perceptions Of Organic Farming

According to the previous studies, there are many possible motives among farmers for adoption to technology /organic production. The farmer motives were classified in a variety of ways including financial/economic, environmental, health/safety, and ideological motives (better

personal and family health, sustainable farming relationship with customers, etc.) On the other hand, numerous potential motives for adoption and possible conversion have been identified through previous studies, there is little research that clarifies how farmers' motives and perceptions may be linked with product sector. While differences in marketing opportunities, differences in institutional support, and differences in investment consideration for different types of organic products have been identified, little research has been done to show how these differences compare with farmers' motives and perceptions regarding organic conversion. The present research study would lucidly illustrate on how farmers' motives for adoption and their opinions of organic agriculture vary with respect to the farmer. Additionally, the investigation on the connection between farmers' motives/perceptions regarding organic adoption with the technology/ innovation may lead to an improved understanding of farmers' rationale in adopting organic production systems that may give rise to a new and improved policies and programs designed specifically for Filipino backyard and commercial hog producers. (Molder, et al., 1991; Burton, et al., 1999; Canavari, et al., 2007; Vogtmann, et al., 1993; Sullivan, et al., 1996; Fairweather, 1999; Kaltoft, 1999; Howlett, et al., 2002; Koesling, et al., 2009; Neimeyer& Lombard, 2003).

Establishing a livestock farm operation requires an integral planning in air and environmental pollution control. (Maya Farms, Philippine s, 1983), the most interesting and impressing report is the absence of foul odor and flies in environmental condition of Gab Farms, Victoria, Laguna. (Philippines,2015) There is inadequacy of literature regarding the adoption of organic hog production systems using EM Tech in the Philippines, and how it is perceived to sustainability of hog productions. This review of literature was conducted to understand how countries were able to integrate sustainable organic hog production into the mainstream of husbandry system. It investigated the background information necessary to provide the EM technology as effective probiotics for hog diseases by the hog producers. It led at understanding why farmers refuse to implement the innovation and technology.

A theoretical framework covering five theories for this study is discussed namely: Supplementation of Effective Microorganism (EM), EMROSA, 2003, Roger's Theory of Diffusion of Innovation, Theory of Reasoned Action, Theory of Planned Behavior, and Theory of Trying.

Roger's Theory of Diffusion Of Innovation

Rogers (2003) defined diffusion as "the process in which an innovation is communicated through certain channels over time among the members of social system" (Rogers, 2003). The four main elements in the Diffusion of Innovations include the innovation, the communication channels, time, and the social system. These elements influence the "innovation decision" process that leads to the eventual adoption of the innovation.

Theory of Reasoned Action (Tra)

According to this model, a person's behavioral intention is strongly related to his attitude towards the behavior. (Ajzen I,1980). The intention is a product of the attitude that an individual developed about the behavior and the subjective norm. One's attitude is formed based of belief and expectations about the behavior. The more an individual believes that the behavior will have positive consequences. "If I decide to buy the product, is it safe and healthy for me" or "will this improve my health and well-being?" The more the attitude towards the behavior becomes favorable, the stronger the intention to patronize or buy the product.

Theory of Planned Behavior

The theory states that attitude toward behavior, subjective norms, and perceived behavioral control, together shape an individual's behavioral intentions and behaviors. To improve on the predictive power of the theory of reasoned action by including perceived behavioural control. It has been applied to studies of the relations among beliefs, attitudes, behavioral intentions and behaviors in various fields such as advertising, public relations, advertising campaigns, healthcare, sport management and sustainability.

Theory of Trying

The Theory of Trying focuses on the assessment of trying to act. It is "an attitude toward a reasoned action is replaced by an attitude toward trying and an intention is restricted to an intention to try" (Carsrud et al., 2009, p.155). There is two main reasons of why consumers may fail to try to consume. Firstly, consumers may fail to consider the options available to them. Secondly, consumers may consciously refrain from buying for various reasons.

To operationalize the study, the conceptual framework

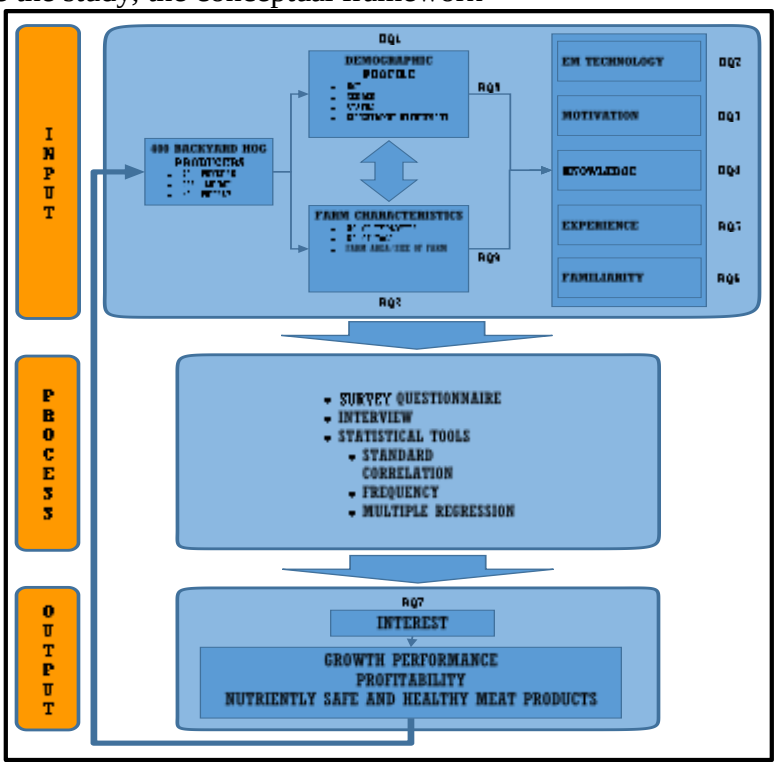

Figure 1. Conceptual Framework

Methods

Sampling Procedure

A stratified random sampling is the method used for identifying cases for this research. Cases were restricted to 400 respondents composed of backyard hog producers in Batangas as shown in Table 1.Using the Yare Tamaro's formula below, sample size was determined:

$$n = \frac{N}{1 + Ne^2}$$

where:

n = size of the sample
N = size of the population
e = margin of error

Table 1. Estimated Total Population of Hogs and Computed No. of Respondents

Site	# of Hogs	Percentage	# of Respondents
Tanauan City, Batangas	5, 390	6%	64
Talisay, Batangas	1, 746	8%	32
Laurel, Batangas	15, 805	76%	304
Total	**20, 941**	**100%**	**400**

Source: Researcher's Survey Data

By Tamaro's formula:

$$sample\ size = \frac{Total\ Population}{1 + (Total\ Population) \times e^2}$$

$$sample\ size = \frac{20{,}941}{1 + (20{,}941) \times 0.05^2} \approx 400$$

Sample Size, Power, And Precision

The paper used of a survey instrument which the researcher formulated based on Review of Literature, and interviews from the key informants. A sample of the Survey Form/ Questionnaire is presented in Appendix C while the key informant interview is presented in Appendix B . The researcher conducted a PRETEST of the 20 respondents situated in the provinces of Laguna, Cavite and Batangas prior a full blown research investigation.

Cronbach's Alpha was used in determining the internal consistency of the data and reliability of the questionnaire. The questionnaire was pretested with 20 respondents and all of items were measured through 6 Likert Scale design. The value of the Cronbach's Alpha based on the items equals to 0.8937, which indicates a good internal consistency; hence the survey questionnaire used is reliable.

Measures

This study used a 6-point Likert scale structured survey questionnaires for the factors identified. The following statistical measures were used in the study: frequency count, and correlation analysis and multiple regression analysis. These were used for computation of variance and correlation. In frequency count, data are classified or itemized according to some particular scheme and a numerical count is done of the number of items on each classification within the scheme. Frequency count is done to present nominal data before other statistical measures can be done. Standard Correlation coefficient formula are used to find how strong a relationship is between data Multiple Regression Analysis was used to study the significant relationship exist between (a) selected variables such as motivation, knowledge, experience, familiarity and other contextual variables such as demographic profile and farm characteristics and (b) interest to adopt to innovation.

$$Y = \beta_0 + \beta_1 x_1 + \beta_2 x_2 + \beta_3 x_3 + \beta_4 x_4 + \beta_5 x_5 + \beta_6 x_6 + \beta_7 x_7$$

Where:
- $\beta_0 \cdots \beta_7$ = unknown parameters to be tested at a 5% level of significance
- Y = Interest
- x_1 = demographic profile
  - Gender: 1 – male, 0 – female
  - Education
    - 1 = college, 0 = high

- 1 = post-graduate, 0 = high school
- Age
- Status

x_2 = farm characteristic
- yrs. in hog business
- population/ no. of hogs
- size of farm

x_3 = Motivation
x_4 = Knowledge
x_5 = Experience
x_6 = Familiarity
x_7 = technology
- 1= w/ technology
- 0 = w/o technology

x_7 = Innovation

The equation above indicates the interest (dependent variable) affected or influenced by $x_1 \cdots x_7$ factors (independent variables). On the other hand, the $\beta_0 \cdots \beta_7$ are the unknown parameters to be tested at 5% level of significance.

Result

Relationship Of Interest To Adopt Em Technology And Other Factors

The correlation between their interest to adopt in EM tech and

1. their motivation to adopt EM tech
2. experience to adopt EM tech
3. their familiarity of EM tech
4. knowledge of EM Tech

Table 2. The Relationship of Interest to Adopt EM Technology and Other Factors

		Interest to Adopt
Motivation	Pearson Correlation	**.323****
	Sig. (2-tailed)	**.000**
	N	**400**
Experience	Pearson Correlation	**.283****
	Sig. (2-tailed)	**.000**
	N	**400**
Familiarity	Pearson Correlation	**.395****
	Sig. (2-tailed)	**.000**
	N	**400**
HEAR	Pearson Correlation	.023
	Sig. (2-tailed)	.642
	N	400
LEARN	Pearson Correlation	.069
	Sig. (2-tailed)	.169
	N	400

Source: Researcher's Survey Data

Table 22 shows the relationship of interest to adopt and other factors (motivation, experience, familiarity and knowledge) of EM technology. Interest to adopt was positively related to motivation, experience and familiarity. The positive relationship indicates that high level of motivation, experience, and familiarity increase the potential to adopt EM tech. Knowledge was not statistically related with interest to adopt EM tech at 5% level.

EM Technology Factors, Farm Characteristics And Demographic Profile Affecting Interest To Adopt

Table 3. The EM Technology Factors, Farm characteristics and Demographic Profile Affecting Interest to Adopt

	B	Standardized coefficients Beta	Sig. (2-tailed)
(Constant)	2.993		0.001
Familiarity	0.180	.305	0.001
Motivation	0.295	.233	0.001
Experience	0.042	.071	0.001
LEARN	-0.006	-.017	0.001
HEAR	-0.038	-.060	0.001
1 = 21-30 yrs old	0.129	.054	0.001
1 = 31-40 yrs old	0.106	.047	0.001
1 = 41-50 yrs old	-0.022	-.010	0.001
1 = 51-60 yrs old	0.205	.080	0.001
1 = male. 0 = female	0.217	.104	0.001
1 = Single	-0.308	-.122	0.001
1 = Married	-0.203	-.097	0.001
1 = Separated	-0.247	-.060	0.001
1 = Elem	-0.793	-.233	0.001
1 = HS	-0.760	-.388	0.001
1 = BS	-0.641	-.321	0.001
1 = MS	-0.382	-.087	0.001
NO. EMPLOYEES	-0.020	-.018	0.001
NO. OF HOGS	-0.001	-.017	0.001
FARM AREA (m^2)	0.000	.082	0.001
Dependent Variable: interest to adopt			

Source: Researcher's Survey Data

Discussion

Summary of Findings

Relationship of Interest to Adopt EM Technology and Other Factors: The correlation between their interest to adopt in EM tech and

1. their motivation to adopt EM tech
2. experience to adopt EM tech
3. their familiarity of EM tech
4. knowledge of EM Tech

Table 2 shows the relationship of interest to adopt and other factors (motivation, experience, familiarity and knowledge of EM technology. Interest to adopt was positively related to motivation, experience and familiarity. The positive relationship indicates that high level of motivation, experience, and familiarity increase the potential to adopt EM tech. Knowledge was not statistically related with interest to adopt EM tech at 5% level.

EM Technology Factors, Farm characteristics and Demographic Profile Affecting Interest to Adopt: Correlation analysis determines the positive and negative direction of relationships between variables. However, the effect of predictors to the dependent variable cannot be determined. The use of multiple regression analysis can detect the effect or influence of predictors to the dependent variable (interest to adopt). Table 3 shows the effects of EM tech factors, farm characteristics and demographic profile to interest to adopt. The standardized coefficients beta indicates the value that determines the factors of EM tech affecting interest to adopt.

Familiarity (0.305), motivation (0.233) and experience positively affects interest to adopt at 5% level of significance. This suggests that high level of familiarity, motivation and experience increase the level of interest of the hog producers to adopt EM tech. knowledge (learn and hear) has a negative influence to interest to adopt EM tech. The negative influence suggests that low level of knowledge on EM technology decrease the level of interest to adopt EM technology.
An arbitrary benchmark was designated in the age groups (0 = 61-above) to compare which age group(s) has the highest level of effect to interest to adopt EM tech. The 51 – 60 years old has the highest interest to adopt EM tech than 61 and above hog producers. Also, the age groups 21 – 30 years old and 31 - 40 years old have higher level of interest to adopt EM tech than the 61 and above hog producers. However, the 61 and above group has a better level of interest to adopt EM tech than 41 – 50 years old hog producers. The results showed that level of interest to adopt EM tech increase with age implying older hog producers have higher level of interest to adopt EM technology.

The male hog producer has a higher level of interest to adopt EM tech than female hog producer. The negative signs for all the indicators of the civil status indicated that widow hog producers have a higher level of interest to adopt EM technology than single, married, and separated hog producers. However, the separated hog producers have the highest level of interest to adopt the EM technology than the single and married hog producers. The results suggest that hog producers with family or have had experience having a family have high level of interest to adopt EM technology.

Educational attainment has negative influence to interest to adopt EM technology at 5% level of significance. The results showed that hog producers with high level of education tend to have lower interest to adopt EM technology. This implies that hog producers with elementary and high school education tend to have better level of interest to adopt the EM technology.
The farm characteristics showed that hog farms with large number of employees tend to have lower level of interest to adopt EM technology. Hog farms with large number of hogs tend to have lower level of interest to adopt EM technology than those hog farms with lesser number of hogs. Hog producers with big farm area has higher level of interest to adopt EM tech than those hog producers with small farm area.

Limitations of The Study

The study focuses only on Effective Microorganism extended solutions such as EMAS—Effective Microorganism Activated Solution and EMRW—Effective Microorganism Rice Wash as probiotics to hog production. It focuses only on the technical efficiency of EM Technology as probiotics taken as food additive and water drink to the fatteners. The use of commercial feeds rather than organic feeds for hog consumption. The study investigated hog raisers whose farms are located within province of Batangas. Four hundred (400) participants were tapped which is further stratified and randomly selected form the following municipalities; 76 respondents in Tanauan, 284 respondents in Laurel and 40 respondents in Talisay. The study had employed a self-formulated questionnaire. The period allocated for the survey (from August to September) also poses constraint. This research study may have an individual-blame bias as it focused only on the industrial end-user, such as hog farmers of organic and non - organic husbandry/ traditional hog raisers. The study does not guarantee full success of the 400 respondents due to several internal and external environmental factors.

Conclusion

The result of the study revealed that the combined extended solution of EM 1 such as EMAS—Effective Microorganism Activated Solution and EMRW—Effective Microorganism Rice Wash were potential stimulus for growth yield and performance in the fatteners. The application is also related to financial returns in shortest time. An increase in operating expenses such as feeds (kg), water and electricity yet EM technology boosts the hog production. However, an increased body weight on fatteners by supplementation of EM culture was due to the effect of EM culture. No single mortality was observed during the entire experimental period.

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