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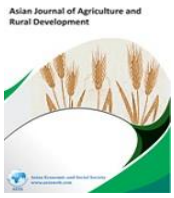

An empirical examination of barriers to acceptance of integrated paddy and beef cattle farming in Indonesia

Sutrisno Hadi Purnomo[a] ✝
Ayu Intan Sari[b]
Shanti Emawati[c]
Endang Tri Rahayu[d]

[a,b,c,d] *Department of Animal Husbandry, Faculty of Agriculture, Universitas Sebelas Maret, Surakarta, Indonesia.*

✝ ✉ sutrisnohadi@staff.uns.ac.id *(Corresponding author)*

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ABSTRACT

This research aims to identify the barriers to the spread of integrated paddy and beef cattle farming and the influence of these barriers on Indonesian farmers' acceptance of integrated farming. Quantitative methods were used to examine the barriers to integrated agriculture acceptance. A direct survey was conducted in which questionnaires were distributed to respondents. In addition, a research framework for the acceptance of integrated agriculture was developed using the technology acceptance model (TAM). Several data analysis methods were employed, including descriptive analysis, confirmatory factor analysis (CFA), and structural equation modelling (SEM). Data were obtained from 310 organic paddy farmers in Boyolali Regency, Central Java, Indonesia. The data were analysed using LISREL 8.8 software to assess the influence of barriers on the acceptance of integrated farming. SEM yielded the following results: x^2 degree 1.77, GFI 0.92, AGFI 0.90, CFI 0.94, and RMSEA 0.06. As a result, we concluded that the goodness-of-fit index met the recommended criteria and that the model corresponded to the data provided, which allowed us to continue with the hypothesis testing. The results of hypothesis testing showed that the factors that significantly influenced the acceptance of integrated farming were barriers in the areas of production, knowledge, government, and economics. The practical implication of the research results is that by reducing barriers to production, knowledge, government, and economics, the acceptance of paddy and beef cattle integration can be increased.

Contribution/Originality: This study examined barriers to the acceptance of integrated farming, including production barriers, knowledge barriers, government barriers, and economic barriers. The results of the research can be used by policymakers to overcome the barriers that arise in the implementation of the integrated crop and livestock system.

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1. INTRODUCTION

The diversification of agricultural practices to extend systems of cropping patterns is encouraged to strengthen food security at the household level by spreading risks across a larger variety of low and high-value outputs (Asante, Villano, Patrick, & Battese, 2018). The implementation of an integrated farming system is a form of agricultural diversification that helps support sustainable agriculture development. An integrated farming system can improve food security, increase product diversity, and lead to a healthy environment and the wider availability of public commodities for rural development (CEC, 2002). Integrated farming systems are more environmentally friendly than other agricultural production methods (Mäder et al., 2002) and their implementation is gaining significant acceptance in many parts of the world. Empirical evidence indicates that integrated farming is effective in rationalizing operational costs, apart from being biologically symbiotic (Alberto et al., 2013). Hisham, Yusoff, Ismail, and Kamarulzaman (2020) demonstrated that the optimization of locally available, affordably priced natural resources through an integrated farming system in Malaysia helps to suppress feed costs. It decreases the reliance on imported feeds. Meanwhile, as defined by Vlahos, Karanikolas, and Koutsouris (2017), integrated farming is a combination of conventional and organic farming that includes several interrelated and interdependent factors to create an environmentally friendly farming practice.

The construction of a production system based on the synergistic and sustainable utilization of soils, animals, and crops is crucial to achieving sustainable intensification. The integrated crop-livestock system (ICLS) has immense potential as an agroecological model (Bonaudo et al., 2014). However, the traditional biodiverse ICLS has become increasingly specialized, which has led to increased efficiency in labour and per unit land area, but has also resulted in detrimental effects on the environment, including pollution, land degradation, market fluctuations, and vulnerability to climate extremes (Garrett et al., 2020; Gil, Garrett, & Berger, 2016).

To achieve sustainable intensification, there is a growing interest in reharmonizing animal maintenance practices with specialized crop farming systems. This strategy is fundamental to ICLS and is believed to foster resilience against extreme climate events by buffering field-level biophysical processes, such as nutrition cycle and crop production improvement (Peterson, Bell, Carvalho, & Gaudin, 2020; Szymczak et al., 2020). ICLS offers more promise than specialized and intensive systems due to its sustainable production and resilience against climate change (Sekaran, Lai, Ussiri, Kumar, & Clay, 2021). The system helps to foster sustainability of animal maintenance and crop farming practices by strengthening regular income from product diversification and autonomy of agricultural inputs (Le Gal et al., 2022).

ICLS is not limited to a certain country or region; it has been widely adopted and practised across the world by integrating locally available crop varieties with diverse livestock commodities that are suitable to the area (Hisham et al., 2020). Previous studies have shown that economic scale is a crucial factor in achieving comparative advantages (Ismail & Abdul, 2014). The integration of livestock maintenance practices with horticultural farming positively affects farmers' incomes and environmental sustainability (Osak & Hartono, 2016).

The integration of Pasundan cattle farming and rice cultivation in West Java has been shown to achieve optimal family income per year with a ratio of 6.02 AU and 0.5 hectares (ha) of rice cultivation (Thawaf, Herlina, Sulistyati, & Fitriani, 2017). The integration of livestock and rice crops has a positive impact, both socially and economically (Syamsu, Ali, Ridwan, & Asja, 2013). Integrated farming systems that combine plantation crops and food crops with livestock are an alternative that can overcome the problems of plantation farming, food crop farming, and animal husbandry (Boonyanuwat & Wongsri, 2016). The integration of crop and livestock production yields several benefits, for instance, increasing soil fertility, increasing crop production, recycling nutrients, increasing land use, and increasing environmental sustainability (Asai et al., 2018; Gupta, Rai, & Risam, 2012; Reddy, 2016).

Although integrated farming has many benefits, conventional farmers encounter technical and economic feasibility issues when transitioning from conventional farming to integrated farming (Peterson, Deiss, & Gaudin, 2020). Barriers to this transition can be economic, technical, social, legal, or cultural (Purnomo et al., 2019). The transition from conventional agriculture to organic farming can also be affected by several factors, including farmers' knowledge of the market, cultivation expertise, capital information, organic product certification, and cultural barriers (Padel, Vaarst, & Zaralis, 2017). Natural resources, market demand, and government policies are also important in the decision to convert from conventional to organic systems (Ullah et al., 2015). Agricultural producers thus face several obstacles to the adoption of integrated agriculture (Harris, Lloyd, Hofny-Collins, Barrett, & Browne, 1998).

Several studies on agricultural technology adoption have used Rogers' (1983) technology acceptance model (TAM) and Davis' (1989) diffusion of innovation (DOI) theory. Davis (1989) argued that technology adoption behaviour results from a person's affective response to innovation. According to Davis (1989), TAM is based on the concepts of perceived usefulness (PU), which is the perception of a technology's usefulness, and perceived ease of use (PEU), which is the perception of the technology's ease of use. These two aspects influence the perceived intention to use (PIU) that technology. The current study investigates the relationship between the barriers to integrated farming acceptance and two aspects of TAM acceptance.

This study examines the barriers to integrated farming according to the model of crop (rice)-livestock (beef cattle) among farmers. We also observe the effects these barriers have on integrated farming acceptance among farmers in Boyolali Regency, Central Java, Indonesia. No previous studies have researched the barriers to implementing integrated crop-livestock systems by conducting empirical testing. Most of the research on integrated farming, such as that of Hilimire (2011), Gupta et al. (2012), Rundengan, Fanani, Subagiyo, and Elly (2013), Munandar, Yakup, and Munawar (2015), Boonyanuwat and Wongsri (2016), and Purnomo et al. (2019), has been based on descriptive analysis. Some studies have investigated the implementation of integrated crop-livestock systems but have not specifically discussed the barriers that occur. For example, Alberto et al. (2013) discussed the economic aspects of ICLS cattle and soybean production, Ismail and Abdul (2014) examined the sustainability of integrated cattle-plantation crop production systems in Malaysia, Vlahos et al. (2017) studied the sustainability of integrated farming, and Gil et al. (2016) researched the determinants of crop-livestock integration in Brazil.

This study examines five barriers as predictors of integrated agriculture acceptance: production barriers, knowledge barriers, infrastructure barriers, government barriers, and economic barriers. Production barriers are related to the following matters: access to materials needed for integrated production, labour availability, time availability, access to facilities, and suitability of weather. Knowledge barriers are related to knowledge and skill of integrated farming, pest management knowledge, and market knowledge. Infrastructure barriers are related to access to transportation equipment, storage for organic produce, equipment processing, and road accessibility. Government barriers are related to the government's policies and commitment to supporting integrated farming. Economic barriers consist of labour costs, market size, and price management. The following hypotheses are developed based on the theory and literature outlined above:

H1: Production barriers have a negative effect on the PU of integrated farming.
H2: Production barriers have a negative effect on the PEU of integrated farming.
H3: Knowledge barriers have a negative effect on the PU of integrated farming.
H4: Knowledge barriers have a negative effect on the PEU of integrated farming.
H5: Infrastructure barriers have a negative effect on the PU of integrated farming.
H6: Infrastructure barriers have a negative effect on the PEU of integrated farming.
H7: Government barriers have a negative effect on the PU of integrated farming.
H8: Government barriers have a negative effect on the PEU of integrated farming.
H9: Economic barriers have a negative effect on the PU of integrated farming.
H10: Economic barriers have a negative effect on the PEU of integrated farming.
H11: PEU has a positive effect on the PU of integrated farming.
H12: PEU has a positive effect on the PIU of integrated farming.
H13: PU has a positive effect on the PIU of integrated farming.

2. MATERIALS AND METHODS

This was a survey-based study using a structured questionnaire instrument as a tool for data collection. The respondents were selected using purposive sampling based on the criteria that they were farmers who had cattle and land for paddy cultivation. A quantitative approach was then used to investigate barriers to the acceptance of integrated farming. We distributed questionnaires to the participants; a total of 310 responses were collected from organic paddy farmers in Boyolali Regency, Central Java, Indonesia. The 36-item questionnaires were answered using a five-point Likert scale ranging from strongly disagree (1) to strongly agree (5). The questionnaire comprised two parts: the first part consisted of 36 questions about barriers to organic agriculture and the second part consisted of questions about individual characteristics. LISREL 8.8 software was used to conduct structural equation modelling (SEM) and confirmatory factor analysis (CFA).

3. RESULTS AND DISCUSSION

The study collected data on the demographic characteristics of the respondents, such as their district of origin, gender, age, education, length of service as an extension officer, and instructor experience. 85% of the respondents were male. Most of the respondents (56%) were between the 40-50 or above 50 age brackets. The most common level of education was elementary school (62%), followed by high school (30%), and a bachelor's degree (8%). Convergent validity is defined by Fornell and Larcker (1981) based on three criteria: composite reliability, factor loading, and average variance extracted (AVE). Each measurement criterion has a threshold value; this is 0.7 for the composite reliability and loading factor and 0.5 for the AVE value. CFA was employed to determine the validity and reliability of the research instrument. The AVE exceeded all construction threshold values of 0.50, and the composite reliability of all factors exceeded the minimum value of 0.70. Except for three items, the factor loading analysis results showed that the majority of the measurements were above and beyond the bare minimum of 0.70. Although the three items did not meet the minimum criteria, the factor loading values ranged from 0.6 to 0.7, meaning that the three items were very close to meeting the minimum measurement criteria.

According to Chau (1997), evaluating the structural model requires building relationships between the variables as stated in the research model. In SEM, the fit index is tested to assess the model's suitability using the root means square error approach (RMSEA), goodness fit index (GFI), adjusted goodness fit index (AGFI), comparative fit index (CFI), and the x^2-squared test statistic. According to Hair, Anderson, Tatham, and Black (1998), a model with a good fit scores equal to or greater than 0.9 for the relative fit index (RFI), normed fit index (NFI), GFI, and CFI, and 0.8 for AGFI, while RMSEA values between 0.05 and 0.08 are acceptable (Bagozzi, Yi, & Phillips, 1991). The structural model analysis yields the following results: x^2 degree 1.77, GFI 0.92, AGFI 0.90, CFI 0.94, and RMSEA 0.06. As a result, we conclude that the goodness-of-fit index meets the recommended criteria and that the model corresponds to the data provided, allowing hypothesis testing to proceed.

The hypothesis testing results are illustrated using path analysis in Figure 1, with the significant pathways in thick lines and paths that are not significant in dotted lines.

This study's coefficient of determination for PU is 72%, which means that this model can explain approximately 72% of the variance. As a result, hypotheses H1, H3, and H7 all prove significant. The coefficient of determination for the PEU variable is 54%, which means that this model can explain 54% of the variance. The hypotheses H2, H4, H8, and H10 are found to be significant. Approximately 68% of the variance in the PIU of integrated farming can be explained by PEU ($\beta = 0.38$, $p < 0.001$) and PU ($\beta = 0.57$, $p < 0.001$). Therefore, hypotheses H11, H12, and H13 are significantly supported.

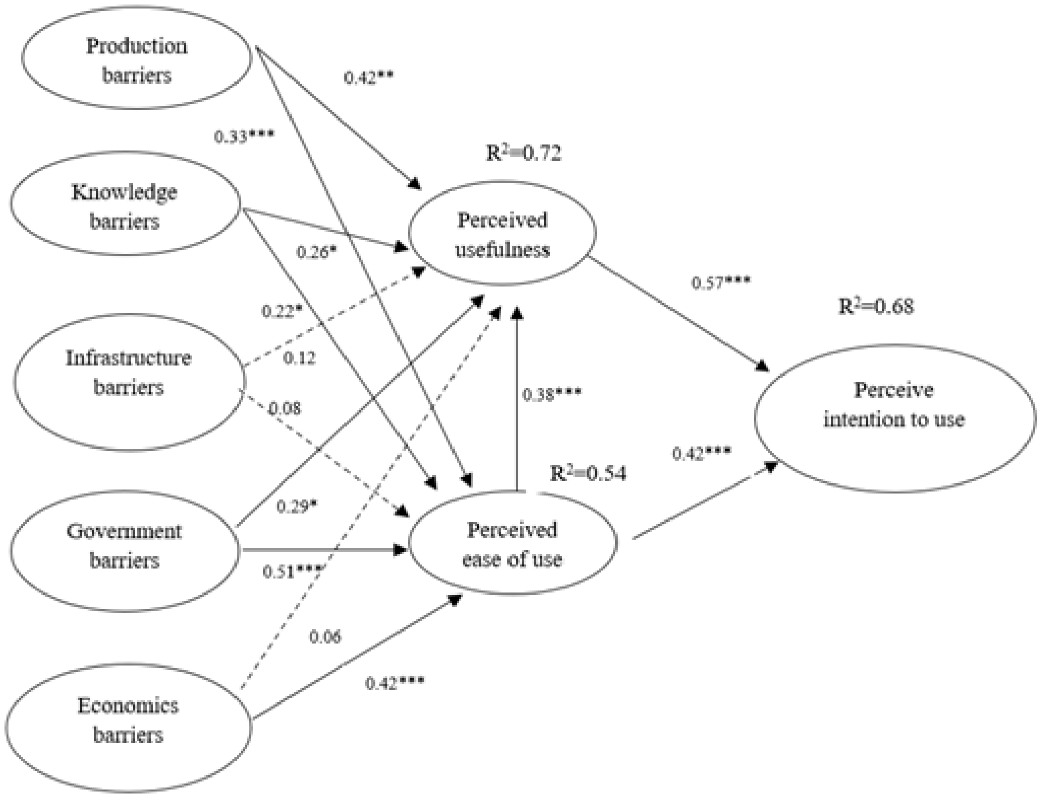

Figure 1. The result of structural model analysis.

Note: * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

The results show that production barriers have a significant effect on the acceptance of integrated farming; this means that there are still barriers for farmers regarding the availability of labour and time and the lack of access to necessary production facilities (manure, organic rice seeds, organic pesticides). On organic rice fields, more labour is needed for land preparation and fertilization because the volume of manure is greater than the volume of inorganic fertilizers. This also results in a longer time required to process and fertilize the soil. The production facilities farmers need, such as manure, organic pesticides, and organic seeds, are not yet readily available. This affects the success of the implementation of integrated farming.

Knowledge barriers also have a significant influence on the acceptance of integrated farming, especially farmers' knowledge of pest control and the marketing of organic agricultural products. Farmers need more knowledge and skills on how to handle pests and plant diseases that occur on organic land, especially weeds, which appear more frequently on organic rice fields than on conventional land. In addition, the marketing of organic rice products is limited to middle and upper consumers who have the ability to buy them; therefore, wider marketing access is needed, especially through the export market.

The results of testing the effects of infrastructure barriers show that they do not affect the acceptance of integrated farming among farmers. These barriers relate to transportation, product storage, and harvest processing equipment. This shows that in terms of infrastructure, farmers do not encounter significant obstacles; this is because farmer groups provide transportation equipment, storage warehouses, and organic rice mills. The local government assists farmer groups with these facilities as part of research programmes.

Government barriers relate to the government's policies and commitment to supporting integrated farming. In this study, government barriers have a very strong influence on the acceptance of integrated farming; this proves that the government plays a very important role by creating policies that support the sustainability of integrated farming. Farmers need government support to increase their knowledge and skills, as well as to provide market access for the sale of organic rice products. In addition, farmers need government support in the form of subsidies for organic label certification on product packaging, because the cost of certification is quite high.

The results of testing the economic barriers variable show that labour costs, market size, and price regulation affect the acceptance of integrated farming through the perceived ease of use. The need for more labour on organic land will increase production costs. In addition, the higher price of organic rice will result in a limited market. Overall, this research proves that the implementation of integrated paddy and beef cattle farming still has barriers that must be overcome to ensure that the implementation of integrated farming is sustainable.

This research differs from previous studies that discuss integrated crop-livestock systems using various methods, such as descriptive, empirical, economic, experimental and case studies. These studies have not specifically examined the influence of barriers on the successful implementation of integrated farming. Several studies on the implementation of integrated farming in various countries around the world from 2011 to 2021 are summarized in Table 1.

Table 1. Previous studies on the topic of integrated crop-livestock systems.

No	Author	Title	Publisher	Type/Topic
1	Hilimire (2011)	Integrated crop/livestock agriculture in the United States: A review.	Journal of Sustainable Agriculture, 35: 4, 376-393.	Descriptive; a review of research, policy, and theory related to integrated agriculture in the USA
2	Gupta et al. (2012)	Integrated crop-livestock farming systems: A strategy for resource conservation and environmental sustainability.	Indian Research Journal of Extension Education, special issue (Volume II), 2012.	Descriptive; challenges and opportunities facing an integrated crop-livestock system to guarantee sustainable production
3	Rundengan et al. (2013)	Integrated farming system model in South Minahasa Regency – North Sulawesi.	IOSR Journal of Agriculture and Veterinary Science (IOSR-JAVS). 5(6): 01-07.	Descriptive; a potential alternative integrated farming system of plantation crops and feed crops
4	Alberto et al. (2013)	Comparison of an integrated crop-livestock system with soybean only: Economic and production responses in southern Brazil.	Renewable Agriculture and Food Systems, 29(3), 230-238.	Economic; the economic side of ICLS cattle and soybean production
5	Ismail and Abdul (2014)	Sustainability of cattle-crop plantations integrated production systems in Malaysia.	International Journal of Development and Sustainability, 3(2), 252-260.	Descriptive; sustainability of cattle-plantation crop integrated production systems in Malaysia
6	Munandar et al. (2015)	Crop-cattle integrated farming system: An alternative of climatic change mitigation.	Journal of Animal Science and Technology. 38(2): 95-103.	Experimental research; activities of integrated crop-cattle farming could be an alternative solution to climatic change-induced mitigation
7	Boonyanuwat and Wongsri (2016)	Integrating Thai native cattle into organic paddy rice farming system in Bokcharearn community.	Rajabhat Agriculture. 15 (1): 22-26.	Economic; comparative study of integrated rice and beef cattle
8	Vlahos et al. (2017)	Integrated farming in Greece: A transition-to- sustainability perspective.	International Journal of Agricultural Resources, Governance and Ecology, 13(1), 43-59.	Case study; the sustainability of integrated farming in Greece
9	Purnomo et al. (2019)	Investigation of barriers to integrated paddy and beef cattle farming in organic agricultural system.	Russian Journal of Agricultural and Socio-Economics Sciences, Vol 1 (85).	Empirical research; investigation of barriers to the implementation of paddy-cattle integration
10	Gil et al. (2016)	Determinants of crop-livestock integration in Brazil: Evidence from the household and regional levels.	Land Use Policy 59, 557-568.	Empirical research; examination of the determinants of crop-livestock integration in Brazil
11	Sekaran et al. (2021)	Role of integrated crop-livestock systems in improving agriculture production and addressing food security – A review.	Journal of Agriculture and Food Research. volume 5, September 2021.	Meta-analysis; advantages, disadvantages, and development of an integrated crop-livestock system

4. CONCLUSION

The barriers that determine the acceptance of integrated farming in Indonesia are production barriers, knowledge barriers, government barriers, and economic barriers. To overcome these barriers, several alternative solutions must be implemented, including providing production facilities, increasing education and extension about integrated farming among farmers, expanding the role of government in providing coaching about integrated farming implementation, and providing the market with promotional products from integrated farming.

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Authors' Contributions: All authors contributed equally to the conception and design of the study.

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APPENDIX

Appendix 1. Questionnaire of Respondent's Profile.

a. Name : ____________________________________
b. Gender : 1. Men 2. Women
c. Age : 1. 20-30 years 3. 40-50 years
2. 30-40 years 4. 50 - 60 years
5.> 60 years old
d. Education : 1. Elementary school 3. High school
2. Junior high school 4. Bachelor
5. Others, please specify ....
e. The main job : 1. Farmers 4. Civil Servants 7. Others, specify .....
2. Breeders 5. Private employees
3. Entrepreneurship 6. Teacher
f. Job experience : 1. 0-5 years 2. 6-10 years 3. 10-15 years 4.> 15 years
g. Rice field area: ________________ hectares / m2
h. Land ownership: self-owned / leased / cultivated land

Appendix 2. Questionnaire of Respondent's perception toward barriers to the application of integrated farming.

1. Strongly disagree 4. Agree
2. Disagree 5. Strongly agree
3. Neutral

Choose one of the answers according to your choice by giving a cross (x) to the available column						
No.	**Question**	**Strongly disagree --- Strongly agree**				
	Production barriers	1	2	3	4	5
1	Lack of access to materials needed for integrated production.					
2	Need a lot of labor in integrated farming.					
3	I don't have enough time for integrated cultivation.					
4	Lack of access to necessary production facilities (Manure, integrated rice seeds, integrated pesticides).					
5	Weather conditions do not allow this type of product integrated cultivation.					
	Knowledge barriers.					
1	I have no skill to cultivate integrated products .					
2	I don't have enough knowledge and education about integrated farming.					
3	I don't know how to do integrated farming.					
4	I don't know how to market integrated produce.					
5	Not enough knowledge to eradicate pests that attack naturally.					
	Infrastructure barriers					
1	Lack of access to transportation equipment for the production of integrated rice.					
2	Lack of access to appropriate places to store integrated rice products.					
3	Lack of equipment to process integrated products until they are ready to be marketed.					
4	Lack of access to transportation equipment for the marketing of integrated rice.					
5	Lack of access road for the production of integrated rice.					
	Government barriers	1	2	3	4	5
1	The government has no commitment to integrated farming.					

Choose one of the answers according to your choice by giving a cross (x) to the available column						
No.	**Question**	**Strongly disagree --- Strongly agree**				
2	The government does not support integrated products.					
3	Lack of government funding subsidies to certify integrated product.					
4	Lack of clear standards for integrated rice production methods from the government.					
	Economic barriers					
1	Labor costs for processing land are too high					
2	The profits obtained are not in line with expectations					
3	People don't pay more to buy integrated products					
4	Traders often reduce the purchase price to farmers					
5	Lack of access to the right market to sell integrated products					
	Usefulness					
1	The application of integrated farming will increase to my knowledge.					
2	The use of integrated farming will increase my agricultural production.					
3	The use of integrated farming will increase my income.					
4	I get that integrated farming is very beneficial in increasing my soil fertility.					
	Ease of use	1	2	3	4	5
1	The application of integrated farming does not require a lot of energy.					
2	The application of integrated farming is very easy.					
3	Integrated farming is in accordance with my wishes.					
4	I get integrated farming easy to do as I do.					
	Intention to use					
1	I will use integrated farming on the next opportunity.					
2	I will always apply integrated farming to my farm.					
3	I would encourage others to use integrated farming.					
4	I think integrated farming is the future of agriculture.					