An Analysis of Waste Utilization Technology Adoption in an Integrated

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An Analysis of Waste Utilization Technology Adoption in an Integrated Crop and Livestock System in Minahasa Regency

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Abstract

The existing farming system in the people of Minahasa Regency is mix cropping; therefore, a zero-waste model integrated agricultural system which is efficient in input use is required. The zero-waste technology model is implemented through various methods or models; among them is integrating corn planting and cattle raising. Introduction to silage feed, ammoniation, and composting was conducted as a waste utilization effort in the crop-livestock integration system in Minahasa Regency. Introduction to the technology was initiated by extension activities where the members of groups were given knowledge of the benefits, production stages, and economic value of silage, ammoniation, and compost. The study was conducted in Minahasa Regency. Sub-district and village samples were determined through purposive sampling based on (1) beef cattle development areas in Minahasa Regency, (2) forage fodder development locations in North Sulawesi, and (3) areas that have conducted corn-cattle integration. The Tonsea Lama Village in North Tondano Sub-district and East Ranotongkor Village in East Tombariri Sub-district were selected. In order to analyze the factors which influence the farmer adoption level in the integration system in Minahasa Regency, a multiple linear regression analysis was employed. The study results revealed that the factors influencing waste utilization technology adoption in the crop-livestock integration system in Minahasa Regency were age, education, and business experience. Out of the three variables, the regression coefficient of age and education had positive values, which means that waste utilization technology adoption in the crop-livestock integration in Minahasa Regency increased with the increase in age and improvement in education. On the other hand, the business experience variable had a negative value, indicating that the respondents felt comfortable with their current business pattern, making them tend to be apathetic towards novel technology.

Keywords: adoption, technology, waste, integration

Introduction

An integrated agricultural system is basically an agricultural system which applied the basic principles of bio-industry, namely: (1) zero waste, (2) zero imported production input, (3) zero imported energy, (4) processing biomass and waste into new, high value bio-products, (5) integrated and environmentally friendly, and (6) as an advanced science and technology-based biorefinery which produces foodstuffs and non-foodstuffs (Haryati 2006, Priyanti et al 2009, Umboh et al. 2017).The existing farming system in the people of Minahasa Regency is mix cropping;

therefore, a zero-waste model integrated agricultural system which is efficient in input use is required. The zero-waste technology model is implemented through various methods or models; among them is by integrating corn planting and cattle raising. The benefits of this activity is that the farmers operating their farms using an integrated agribusiness model is efficient in input use, environmentally friendly (zero waste), and have an impact on food and processed food product diversity (Diwyanto et al 2002, Umboh et al. 2016).

Pertaining to cattle-raising technology, introduction of technology components, namely young cattle selection, enclosures, feed management, disease and pest control, and marketing has been conducted extensively. However, it is still difficult to change the cattle-raising method, in feeding, enclosures system, and waste utilization. This condition indicates that technology introduction in the practical level is not as simple as discovering a laboratory-scale formula due to the varying appreciation responses from the farmers towards technological innovations.

The classical farmer-level problem is that extension/training activities have yet to have any effect on the farmers' behavior in adopting novel technology, frequently resulting in the farmers deciding to reject the technology. Even though the technology being introduced is the result of improvements to or modification of existing technology, it is not enough to persuade the farmers to adopt the technology. This is because technology adoption at farmer level does not occur as a whole technology package, but is limited to the components of the technology. In addition, the factors which influence technology adoption at farmer level are still unknown.

Based on the aforementioned issue, the pupose of this study was to analyze the factors influencing farmers' technology adoption in the corn-cattle integration system in Minahasa Regency.

Material and Method

The study was conducted in Minahasa Regency. Sub-district and village samples were determined through purposive sampling based on (1) beef cattle development areas in Minahasa Regency, (2) forage fodder development locations in North Sulawesi, and (3) areas that have conducted corn-cattle integration. The Tonsea Lama Village in North Tondano Sub-district and East Ranotongkor Village in East Tombariri Sub-district were selected. To analyze the factors which influence the farmer adoption level in the integration system in Minahasa Regency, a multiple linear regression analysis was employed.

Results and Discussion

Corn Waste and Cattle Dung Utilization Technology Introduction

The introduction of silage-making, ammoniation, and compost was done as an effort to utilize waste in the crop-livestock integration system in Minahasa Regency. Technology introduction was initiated by extension tension activities where farmer group members were given the knowledge of the benefits, production stages, and economic value of silage, ammoniation, and compost. This was conducted because the group members had no knowledge of the waste utilization technology introduction package in the crop-livestock integration system.

The technology introduction in silage feed production and ammoniation of corn stalks were conducted to overcome feed shortages in the dry season. Farmers had to look far for grass on agricultural land and even resorted to purchasing bran and oilcake to fulfil the catlle's feed requirements. On the other hand, during harvest season, the farmers simply ignored, discarded, or burned corn-stalk waste after harvesting. This was because the farmers did not have the knowledge of alternative feed through the utilization of abundant agricultural waste. The farmers' knowledge was limited to feeding roughage directly to the cattle although the crop waste had great potential as a raw ingredient for a complete feed which could overcome cattle feed shortages, especially during the dry season. Technology introduction was done collectively without other group members through a number of stages: the collection and transportation of corn stalks from fields belonging to members, drying, silage-making/ammoniation, packing, and finally the product was ready to feed to the cattle.

At farmer level, livestock dung was unused and wasted and caused pollution. Introduction to compost was conducted as an effort to improve and increase the diversity of soil organisms. Through the processing and introduction to waste technology, livestock waste could be processed into organic fertilizer which has multiple benefits; aside from being beneficial for the crops, it can also improve the nutrients in the soil which cannot be done by chemical fertilizers (Simatupang 2004, Umboh et al 2017). Moreover, the rising prices of inorganic fertilizers or factory-produced chemical fertilizers make the production of compost a profitable business opportunity.

Factors Influencing Technology Adoption

The process of technology adoption is the process of applying a novel idea. In this case, the technology adoption level can be assessed through the quality and quantity of adoption. The quality and quantity of adoption are associated to the accuracy and number of technology components applied to the agribusiness according to the guidelines (Rogers 2003, Bulu et al 2009, Abdullah et al 2015, Kabir et al 2013) listed five stages of the adoption process: awareness, interest, evaluation, trial, and adoption. Based on the information above, technology adoption in this study is defined as farmers' ability to apply waste utilization technology in the integrated system which is categorized as: accepting is given a score of 3, dubious is given a score of 2, and rejecting is gven a score of 1.

The study results revealed that the factors which influence waste processing technology adoption in the corn and cattle integration system were both internal and external factors. These factors were age, education, and business experience. The regression analysis results demonstrating that the three variables had a significant effect on the waste utilization adoption level in the integrated system in Minahasa Regency can be seen in Table 1.

Table 1. The Result of Regression Analysis

Independent Variable	Dependent Variable	Coeficient Regression	Thit	Sig.
Constanta	Technology Adoption (Y)	2.021	3.452	0.001
Age (X1)		0.116	0.751	0.56
Education (X2)		0.111	0.519	0.064
Business Experience (X3)		-0.156	-1.055	0.48
Rsquare=0.782				

Age

Pertaining to the agricultural technology adoption context, the age concentration at productivce age can become a resource asset which will increase the speed of agribusiness technology adoption. Generally, the respondent farmers in this study were between 39 and 57 years old (56.25 percent), followed by those 58 – 75 years old (31.25 percent), and the remaining 8 percent were 20 – 38 years old. These data demonstrated that the farmers were within the productive age range (Table 2).

Table 2. Farmer's Age in Integrated System in Minahasa Regency

No	Indicator (year)	Scor	Farmer (Respondent)	Percent (%)
1	58 – 75	3	15	31.25
2	39 – 57	2	27	56.25
3	20 – 38	1	6	8
			48	100

Source: Primary Data (processed), 2018

The result of the regression analysis showed that the regression coefficient of the age variable (X1) was 0.116, meaning that for every increase in the age value would cause an increase in adoption value by 0.116 percent, with a ceteris paribus assumption. This indicates that the farmers' age influences the speed of technology adoption. This result was not in line with the results of the the study by Rangkuti (2009) who stated that the older the farmer is, the less his/her involvement in the communication network.

Education

Education can influence a farmer's ability to adopt a novel technology. The higher the farmer's education level, the faster he/she grasps the understanding of a new technology. Education reflects the intelligence level which is related to a person's cognitive ability. The higher a person's education level, the more extensive his/her knowledge is lower. This was supported by the opinion by Rogers (2003), Musyafak and Ibrahim (2005), Bulu et al. (2009). who stated that education influences a person's understanding in learning something, either a skill or knowledge. The implication is that the farmers did not have the courage to adopt a technology because they were ignorant of the benefits of the technology. Therefore, the farmers' education variable is a significant determining factor in making the decision to adopt new technology.

The Education Level regression coefficient (X2) was 0.111 which means that every increase in the education value would cause an increase in the technology adoption value by 0.111 percent with a ceteris paribus assumption. This result indicates that farmers with high education relatively quickly applied the suggestions from the extension officials. On the other hand, farmers with minimum education were generally reluctant to accept/increase their knowledge. Rogers (2003) stated that the level of formal education undergone by farmers reflects the farmers' knowledge level and outlook in applying introduced technology.

The result of the study revealed that the largest percentage of farmers in the integrated system in Minahasa Regency finished elementary school (45.83 percent), followed by farmers who graduated from junior to senior highschool (37.50 percent), and those who had college diplomas (16.66 percent) (Table 3). This indicated that the education level was still low, leading them to believe that adequate education isunnecessary for raising livestock.

Table 3. Farmer's Education in Integrated System in Minahasa Regency

No	Indicator (formal education)	Scor	Farmer (Respondent)	Percent (%)
1	Diploma – PT	3	8	16.66
2	SMP – SMA	2	18	37.50
3	SD	1	22	45.83
			48	100

Source: Primary Data (processed), 2018

The implication of the low level of the farmers' formal education is that they need supervision in the order to increase the speed of adoption of technological innovations. Rogers (2003), Abdullah et al. (2015) stated that education is one of the factors which strongly influential in the livestock-raising business. An adequate education level would have an effect on the ability to manage the livestock-raising business. In other words, the higher a person's formal education, the faster he/she adapts to developments in technology and it could also increase a person's thought processing speed.

Business Experience

There was an apparent disparity in the respondent farmers' livestock-raising business experience, between 2 and 40 years. A person's livestock-raising business experience shows how long the person has been involved in the business. The more experience in the livestock-raising business, the higher the farmer's involvement, diversity, collaboration, and openness in the communication network with other farmers. The bond strength is one of the determining indicators for the speed of technology adoption. Business experience (X3) in this study is defined as the length of time the farmer has been running a business in the integrated corn-catttle system.

Business experience influences decision-making in the option to adopt a certain technology. The more the experience in the agribusiness, the more easily a person will understand a technological innovation and he/she tends to apply it more readily (Simatupang 2004, Musyafak and Ibrahim 2005). Priyanti et al. (2007) stated that an integrated agribusiness technological innovation is the result of modifying yang technology aimed to assist farmers in their agribusiness activities. The results of this study revealed that the farmers in the integrated system in Minahasa Regency had business experiences between 2 and 40 years. This can be seen in Table 4.

Table 4. Farmer's Business Experience in Integrated System in MInahasa Regency

No	Indicator (year)	Scor	Farmer (Respondent)	Percent (%)
1	28-40	3	9	18.75
2	15-27	2	17	35.14
3	2-14	1	22	45.83
			48	100

Source: Primary Data (processed), 2018

Table 4 shows that the largest percentage of farmers had business experience in the integrated system ranging between 2 to14 years, forllowed by 15 to 27 years, and finally 28 to 40 years. The Experience regression coefficient (X3) was -0.156 which means that for every increase in business experience value would decrease the adoption value by 0.156 percent with a ceteris paribus assumption. This condition indicates that the more business experience a farmer has, the more difficult it is for him/her to accept and and apply novel technology. This was opposite of the findings by Rogers (2003) who stated that the more experience a person has in an agribusiness, the more easily he/she understands a technological innovation and the more readily he/she applies it . Business experience can indicate a deep understanding of the current business, leading to thoughts of making the task easier or the will to increase his/her business's productivity using the available resources. In the case in this study, the respondent farmers were in a business pattern comfort zone, making them apathetic towards novel technology. This was due to more extensive experience which allowed them to make more comparisons in making their decision. The results of this study are supported by Umboh et al (2016), but not supported by Rahardi (2003) who found that farmers who have much experience in an agribusiness would apply innovations more quickly than beginner farmers.

Conclusion

Waste utilization technology adoption in the corn-cattle integration system was significantly influenced by age, education, and business experience. From these three variables, the regression coefficients for age and education had positive values, meaning that waste utilization technology adoption in the corn-cattle integration system in Minahasa Regency were proportional to the variables age and education. On the other hand, the business experience variable was inversely proportional, indicating that the respodents were within a comfort zone in their agribusiness, making them apathetic towards certain technology.

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