RJOAS: Russian Journal of Agricultural and Socio-Economic Sciences
ISSN 2226-1184 (Online) | Issue 3(147), March 2024

UDC 636

INFLUENCE OF FARMERS CHARACTERISTICS AND ENVIRONMENTAL SUPPORT ON LIVESTOCK SECTOR THROUGH INNOVATION CHARACTERISTICS: APPLICATION OF COMPOST MANAGEMENT TECHNIQUES IN JAMBI PROVINCE

Afriani H.*
Postgraduate Doctoral Program, University of Jambi, Indonesia

Adriani, **Firmansyah**, **Pramusintho Bagus**
Study Program of Animal Husbandry, Faculty of Animal Husbandry,
University of Jambi, Indonesia

*E-mail: afriani.h@unja.ac.id

ABSTRACT
Compost is an organic fertilizer made from plant residues and animal waste that has undergone a decomposition process. Compost must be managed using good techniques to become a product with sales value and can be used to fertilize agricultural plants. This research aims to analyze the application of management techniques compost in Jambi Province and the factors that influence it. This research uses a survey method. The sampling technique was carried out in 3 (three) stages, namely, the first stage, selecting districts using the *simple random sampling method.* The second stage selects sub-districts, and the third stage selects villages with farmers or farmers who manage compost using *simple random sampling*. The application of management techniques compost is measured based on the percentage of application, which is further classified into three categories: low, medium, and high. The Structural Equation Modeling analysis model with Partial Least Square is used to analyze factors that influence the application of management techniques compost in Jambi Province. The research results showed that the average application of compost management techniques was 73%, which is in the medium category. Farmer characteristics and environmental support in the livestock sector directly influence applying compost management techniques in Jambi Province. In contrast, innovation characteristics do not significantly mediate the indirect influence of breeder characteristics and environmental support in the livestock sector on the application of compost management techniques.

KEY WORDS
Application, compost, management techniques, cattle.

With the development of cattle farming in Jambi Province, both fattening and rearing broodstock-producing calves, it is inevitable that there will be residual business (waste), namely in the form of cow dung, urine, and feed waste. On average, a cow produces around 8 – 10 kg of feces daily (Huda and Wikanta, 2017) and 10-15 liters of urine/day (Sunarto and Lutojo, 2008). Data on the cattle population in Jambi Province in 2020 amounted to 160,261 heads (Jambi Province Central Statistics Agency, 2021). This means it can produce 467,962 – 584,952 tons of fresh feces and 585 – 877 million liters of urine every year. The yearly waste is enormous and will cause environmental problems if not appropriately managed (Pongracz and Pohjola, 2004; Gupta *et al.*, 2016; Tallou *et al.*, 2020). However, organic cow dung waste can be converted into a resource by implementing appropriate recycling systems (Brown, 2003; Gupta *et al.*, 2016).

Many ways can be used to process livestock waste, including simple processing of cow dung into manure, but this method is the leading cause of odor and fly problems in rural areas (Yadav *et al.*, 2013). Therefore, waste from cattle farming businesses must be managed in better ways or techniques so that it can become a product that has sales value that can contribute to the family economy; besides that, it can be used to fertilize crops and plantations which are cultivated by many farmers in Jambi Province so that it can reduce production costs to buy inorganic fertilizer. This is in line with the opinion of He (2020), who stated that the use of processed waste products from cattle farming significantly increases agricultural production and supports the concept of sustainable agricultural development.

Another way that farmers can do this is to process waste into compost. Farmers in Jambi Province, individually and in groups, have processed cow dung into compost. This condition is driven by the 2011 Minister of Agriculture Regulation on Organic Fertilizers, Biological Fertilizers, and Soil Improvements. However, in practice, farmers still face problems because there are no compost processing standards, so there are differences in management techniques, including the composition of the materials used, mixing, length of composting time, and turning. Another problem is product utilization; some farmers find it difficult to market compost due to the lack of function of farmer groups and cooperatives in developing networks for product marketing.

Cattle waste processing/composting is an innovation for farmers. An innovation is an idea, practice, or object considered new by an individual or other adoption unit (Rogers, 2003). An innovation will be useless without adoption. As stated by Bortamuly and Goswami (2015), technology adoption is the application or execution of information obtained for a particular innovation.

A household's decision to adopt or not adopt new technology is generally indirect and rarely occurs quickly (Pierpaoli et al., 2013) because many factors influence the adoption process (Rogers, 2003; Dimara and Skuras, 2003). The decision to implement or adopt is complex, considering the barriers and constraints at the farmer household level. Usually, households or individuals will make the choice to adopt if the innovation provides great benefits for them (Yasmin and Grundmann, 2019).

Even though many farmers in Jambi Province have processed livestock waste, quite a few have not implemented it. Factors that determine the adoption or implementation of innovation include farmer characteristics, innovation characteristics, facilities and infrastructure, and the role of extension workers and institutions (Mwangi and Kariuki, 2015; Theis et *al.*, 2018; Atsriku, 2020).

MATERIALS AND METHODS OF RESEARCH

The method used in this research is a survey method. The sampling technique was carried out in 3 (three) stages, namely: the first stage, district selection was carried out in cattle development areas, one district each in Jambi Province representing the eastern, central, and western regions. The choice of selected communities used simple random sampling. In the second stage, sub-districts with groups of farmers or farmers who managed compost were chosen using a simple random sample in each district. In the third stage, in each sub-district, villages that had groups of farmers or farmers who managed compost were selected using simple random sampling. Next, respondents were taken from each village chosen using simple random sampling. Primary data collection was carried out by interviewing respondents and observing based on a questionnaire prepared per the research objectives. This research uses various data scales (ordinal and ratio). A structured questionnaire was prepared (based on a five-point Likert scale) to collect data on innovation characteristics, while ratio data was used for data on farmer characteristics. Application of management techniques compost using the e-score method (quantitated) with a list of determining factor components (impact points). Measuring compost management techniques based on the percentage of application is then classified into three categories: low, medium, and high. To see the influence of farmer characteristics and environmental support in the livestock sector through innovation characteristics on the application of compost management techniques in Jambi Province, the Structural Equation Modeling with Partial Least Square (SEM -PLS) analysis model was used.

RESULTS AND DISCUSSION

Compost management techniques include collection, preparation, mixing, storage, turning, harvesting, and utilization activities. Collection techniques are seen from the frequency of cow feces collection and post-collection activities. The research results regarding collection techniques were 75.00%; this means that the implementation is relatively high; this is because 25.86% of farmers collect feces every day, and 32.76% of farmers collect cow feces more than once a week, meaning that the majority of farmers We routinely collect feces to maintain the continuity of raw materials for making compost. Before processing it into compost, 34.48% of farmers have tried to reduce the water content of the feces by letting it sit before processing compost, and 36.21% of farmers have also tried to leave most of the feces collected first so that the water can drain. This technique needs to be done because cow dung has a high water content ranging from 75 - 85%; if not done, it will cause the composting process to become anaerobic and will cause an unpleasant odor (Hapsari, 2018).

Table 1 – Application of Compost Management Techniques

No	Compost Management Techniques	Application (%)
1.	Collection	75.00
2.	Preparation	64.00
3.	Mixing	84.00
4.	Storage	71.00
5.	Reversal	67.00
6.	Harvesting	78.00
7.	Utilization	72.00
	Average (%)	73.00
	Category	Currently

Note: category 20.00% - 46.67% = low, 46.68% - 73.33% = medium, 73.34% - 100.00% = high.

In the preparation technique, the activities include preparing materials and solutions and chopping up the compost-making materials. The research results on preparation techniques were classified as moderate (64.00%). This is because there are differences in the composition of the materials and solutions used. Some farmers use an ingredient formula of 30% cow feces, 30% palm waste, 20% fiber, 20% palm fronds, and 1 kg/ton of bran. 1 liter EM4 solution: 20 liters water: 1 kg sugar. Meanwhile, some farmers use an ingredient composition of 25% cow feces, 15% solids, 20% tangkos, 20% boiler ash, 20% palm fronds, and 2 kg bran—1 liter EM4 solution: 40 liters of water: 1 liter of molasses. Differences in the material formula and solution will undoubtedly affect the compost quality. Compost from feces can be obtained with the best results if the right ingredients are added (Pantura *et al.*, 2021). Prihandini and Purwanto (2007) stated that the materials and solutions needed for making compost consist of: 1) Cow dung after draining, 2) Husk as much as 10% of the weight of cow dung, 3) Husk ash as much as 10% of the weight of cow dung, 4) Rice bran as much as 5% of the weight of cow dung, 4) EM-4 solution + drops + water (2: 2: 1000) or 1 liter of water + 2 cc of EM-4 + 2 cc of drops or 1 liter of water + 2 cc EM-4 + 6 tablespoons granulated sugar.

Mixing includes techniques for mixing ingredients, techniques for mixing solutions, and overall mixing techniques (materials and solutions). The application of mixing techniques is in the high category (84.00%). Farmers have applied the correct mixing technique by spraying the solution (bioactivator) evenly on the mixture of feces and compost-making material so that the bacteria are mixed evenly in the compost-making material and the composting process runs well.

The application of storage techniques is 71.00% because 24.14% of farmers have not considered the height of the composting material during the composting process. The higher the embankment volume, the easier it will be for the dam to become hot; conversely, if it is too shallow, it will cause rapid heat loss. In conditions where the temperature is less than optimal, the bacteria that work on the pile will not develop properly; as a result, composting will take longer (Directorate General of Processing and Marketing of Agricultural Products, 2015).

Meanwhile, the reversal technique is only 67.00% because, in general, farmers do not check the temperature; farmers only hold the compost pile, and if they feel the temperature is increasing (hot), the covering tarpaulin will be opened, and when the temperature has returned to normal, the covering tarp will be put back on. Under aerobic conditions, fermentation will occur quickly, increasing the temperature by 35 - 40ºC. Prihandini and Purwanto (2007) argue that if the temperature reaches 50ºC, the compost is turned over to let air in, and the temperature drops. Turning over piles of compost material during the decomposition process is necessary and helpful in regulating the oxygen supply for microbial activity (Directorate General of Processing and Marketing of Agricultural Products, 2015).

Farmers generally harvest compost when it is cold, blackish brown, odorless, earthy, and crumbly. This means that the application of harvesting techniques is relatively high (78.00%). Meanwhile, the application utilization technique was 72.00%. Some of the compost produced is sold, and some is used for personal use to fertilize agricultural land.

The research results found that the average application of compost management techniques in Jambi Province was 73.00%, which is categorized as medium. From these results, it can be explained that the methods for collecting, mixing, and harvesting must be maintained, while for the preparation stage, there needs to be a standard formula that can be used as a guide for farmers in managing compost so that good quality compost is obtained, likewise for the turning technique, it is necessary to be equipped with a temperature measuring thermometer. So that you can know the right time to turn so that the composting process runs well. The application of storage techniques also needs improvement, with an ideal height of around 1 meter.

The measurement model in this research consists of a reflective measurement model where farmer characteristics, innovation characteristics, environmental support for the livestock sector, and the application of compost management techniques are measured reflectively. Hair et al. (2006) stated that the evaluation of the reflective measurement model consists of Factor Loading ≥ 0.70, Composite Reliability ≥ 0.70, Cronbach's Alpha ≥ 0.70, and Average Variance Extracted (AVE ≥ 0.50), as well as evaluating discriminant validity, namely the Fornell Lacker and Cross Loading criteria. The initial step in developing the model was identifying the factors that influence applying compost management techniques in Jambi Province.

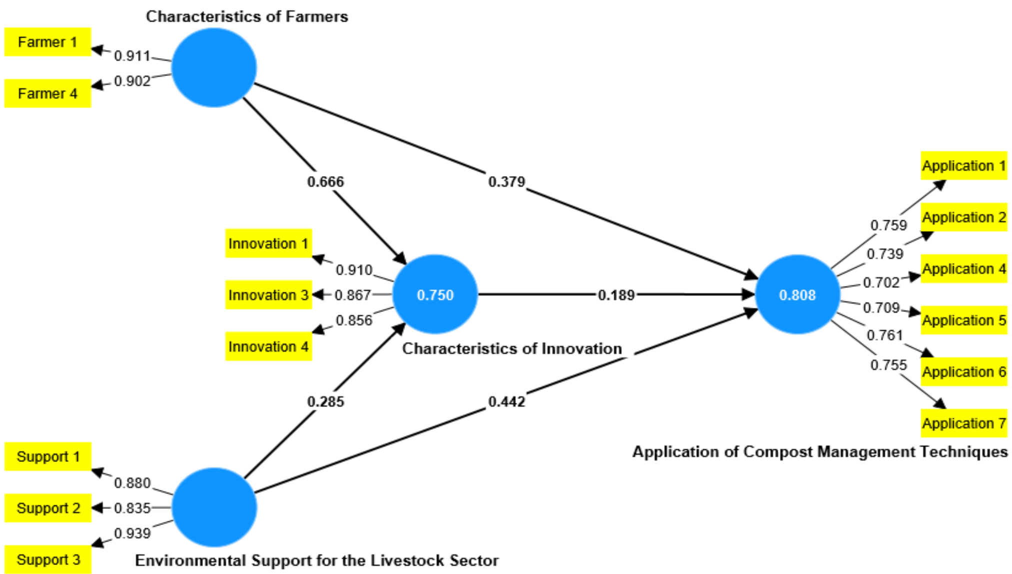

Figure 1 – Structural Model of Application of Compost Management Techniques

After respecificating the model (Figure 1), all factor loading values are above 0.70 (Table 1). This means that the model construct meets the convergent validity criteria, or, in other words, the indicators used are valid to measure each latent variable in modeling the application of compost management techniques. The next stage is to check the results of the Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE) tests.

Table 2 – Outer Loading Results

No	Variable	Measurement Items	Indicator	Outer Loading
1	Environmental support for the livestock sector	Support 1	Facilities and infrastructure	0.880
		Support 2	Extension services	0.835
		Support 3	Institutional role	0.939
2.	Characteristics of innovation	Innovation 1	Relative advantage	0.910
		Innovation 3	Complexity	0.867
		Innovation 4	Triability	0.856
3.	Characteristics of farmers	Farmer 1	Experience	0.911
		Farmer 4	Number of livestock	0.902
4.	Application of compost management techniques	Application 1	Collection	0.759
		Application 2	Preparation	0.739
		Application 4	Storage	0.702
		Application 5	Reversal	0.709
		Application 6	Harvesting	0.761
		Application 7	Utilization	0.755

Table 3 – Cronbach's Alpha, Composite Reliability, and Average Variance Extracted (AVE) Test Results

No	Variables	Cronbach Alpha	Composite Reliability	Average Variance Extracted (AVE)
1.	Environmental Support for the Livestock Sector	0.861	0.916	0.784
2.	Characteristics of Innovation	0.851	0.910	0.770
3.	Farmer Characteristics	0.782	0.902	0.821
4.	Application of Compost Management Techniques	0.833	0.877	0.544

In Table 3, the Cronbach's alpha test results are more significant than 0.7. These results indicate that all latent variable constructs are declared reliable, and the Composite Reliability test results are >0.7. Based on these results, all constructs have good reliability criteria. The AVE value for all constructs is >0.5; this means there are no Convergent Validity problems in the tested model. Next, a discriminant evaluation was carried out using the Fornell Lacker and Cross Loading criteria.

Table 4 – Fornell and Lacker criteria

No	Measurement Items	Environmental Support for the Livestock Sector	Characteristics of Innovation	Farmer Characteristics	Application of Compost Management Techniques
1.	Environmental Support for the Livestock Sector	0.885			
2.	Characteristics of Innovation	0.680	0.878		
3.	Farmer Characteristics	0.593	0.835	0.906	
4.	Application of Compost Management Techniques	0.796	0.807	0.799	0.738

Evaluation of discriminant validity needs to be done by looking at the Fornell and Lacker criteria. Discriminant validity is a form of assessment to ensure that variables are theoretically different and proven empirically/statistically tested. Fornell and Lacker's criterion is that the root AVE of the variable is greater than the correlation between the variables (Hair et al., 2006). The environmental support variable for the livestock sector has a more excellent AVE root (0.885), a more significant correlation with innovation characteristics (0.680), a more excellent correlation with farmer characteristics (0.593), and a more significant correlation with environmental support for the livestock sector. These results indicate that the livestock sector's ecological support variable's discriminant validity is met. Likewise, for other variables, the discriminant validity is met.

Table 5 shows that farmer characteristics are more strongly correlated with farmer characteristics and weakly correlated with other variables. This means that all farmer characteristic items (KP1 and KP2) measure the farmer characteristic variables they measure and correlate lower with other variables; this means that discriminant validity is met, and for other variables, the discriminant validity is fulfilled.

Evaluation of the structural model is related to testing the hypothesis of influence between research variables. The structural model examination was carried out in three stages: first, checking the absence of multicollinearity between variables and the Inner VIF

(Variance Inflated Factor) measure. Second, hypothesis testing between variables is done by looking at the statistical t-value or P-value. Third, the f square value, namely the influence of direct variables at the structural level and f square mediation effects.

Table 5 – Cross-Loading Test Results

No	Measurement Items	Environmental Support for the Livestock Sector	Characteristics of Innovation	Farmer Characteristics	Application of Compost Management Techniques
1.	Farmer 1	0.611	0.769	0.911	0.745
	Farmer 4	0.460	0.744	0.902	0.703
2.	Support 1	0.880	0.571	0.499	0.697
	Support 2	0.835	0.518	0.518	0.683
	Support 3	0.939	0.704	0.557	0.735
3.	Innovation 1	0.616	0.910	0.772	0.721
	Innovation 3	0.504	0.867	0.746	0.600
	Innovation 4	0.659	0.856	0.682	0.790
4.	Application 1	0.437	0.568	0.606	0.759
	Application 2	0.683	0.545	0.464	0.739
	Application 4	0.622	0.555	0.665	0.702
	Application 5	0.624	0.646	0.542	0.709
	Application 6	0.465	0.632	0.590	0.761
	Application 7	0.654	0.617	0.655	0.755

Table 6 – Inner VIF

No	Measurement Items	Application of Compost Management Techniques	Characteristics of Innovation
1.	Application of Compost Management Techniques	-	-
2.	Characteristics of Innovation	3,996	-
3.	Farmer Characteristics	3,313	1,542
4.	Environmental Support for the Livestock Sector	1,866	1,542

Table 6 shows that innovation characteristics, farmer characteristics, and environmental support in the livestock sector influence the application of compost management techniques. These three variables are lowly correlated because they have an Inner VIF value below 5, meaning there is no high multicollinearity between innovation characteristics, farmer characteristics, and environmental support. The livestock sector influences the application of compost management techniques, the characteristics of farmers, and ecological assets for the livestock sector in influencing the innovation characteristics of Inner VIF values below 5. Inner VIF values below 5 indicate no multicollinearity between variables (Hair et al., 2006). The complete results of hypothesis testing can be seen in Figure 2 and Table 7.

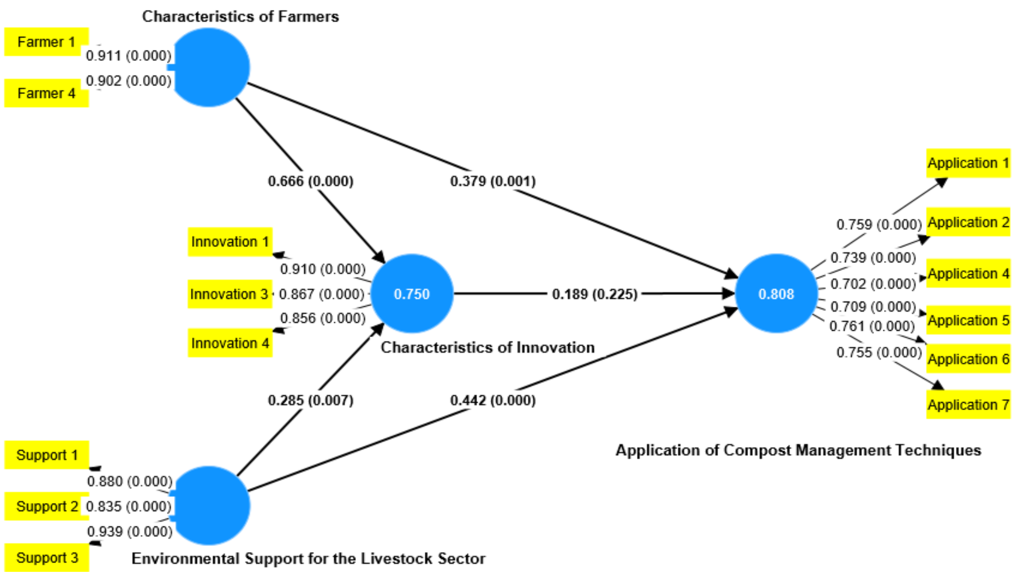

Figure 2 – Direct Effect Bootstrapping Results

Based on Table 7, it can be seen that there is a significant influence of farmer characteristics on innovation characteristics with Path Coefficient (0.666) and P-value (0.000<0.05). Every change in the characteristics of farmers will increase the characteristics of innovation. In the 95% confidence interval, the influence of innovation characteristics in increasing the application of compost management techniques is between 0.436 and 0.822. The existence of farmer characteristics in improving innovation characteristics has a moderate/moderate influence at the structural level (F Square = 1.149). The f-square value is 0.02 low, 0.15 moderate, and 0.35 high (Hair et al., 2006). There needs to be an effort to improve the characteristics of farmers so that the innovation characteristics can increase to 0.822. The way that can be taken is to increase the number of livestock because this will be related to the supply of raw materials for making compost. Apart from that, it is necessary to increase the experience of farmers. According to Roger (2003), The longer a person's experience in farming, the easier it will be to understand a technological innovation and the easier it will be to implement it.

Table 7 – Hypothesis Testing Results

No	Hypothesis	Path Coefficient	P-Value	95 % Confidence Interval Path Coefficient		F Square
				Lower Limit	Upper Limit	
1.	Farmer Characteristics -> Innovation Characteristics	0.666	0,000	0.436	0.822	1,149
2.	Livestock Sector Environmental Support -> Innovation Characteristics	0.285	0.007	0.098	0.517	0.211
3.	Farmer Characteristics -> Application of Compost Management Techniques	0.379	0.001	0.113	0.579	0.226
4.	Environmental Support for the Livestock Sector -> Application of Compost Management Techniques	0.442	0,000	0.203	0.620	0.545
5.	Innovation Characteristics -> Application of Compost Management Techniques	0.189	0.225	-0.069	0.543	0.047

The environmental support variable in the livestock sector is a factor that has a positive influence on innovation characteristics with Path Coefficient (0.285) and P-value (0.007<0.05). Every change in environmental support for the livestock sector will increase the characteristics of innovation. In the 95% confidence interval, the influence of innovation characteristics in increasing the application of compost management techniques is between 0.098 and 0.517. Environmental support in the livestock sector in improving innovation characteristics has a moderate/moderate influence at the structural level (F square = 0.211). Therefore, it is necessary to increase environmental support for the livestock sector from the government, private sector, and groups to increase innovation characteristics to 0.822. Luciani et al. (2015) argue that the support of cooperatives as non-governmental economic institutions plays a role in the diffusion of innovation to farmers, namely introducing innovation, facilitating capital, procurement, and service of production facilities, and marketing.

There is a significant influence of farmer characteristics on the application of compost management techniques with Path Coefficient (0.379) and P-value (0.001<0.05). Any changes in the characteristics of farmers will increase the application of compost management techniques. In the 95% confidence interval, the influence of farmer characteristics in expanding the application of compost management techniques is between 0.113 and 0.579. The existence of farmer characteristics in increasing the application of compost management techniques has a moderate/moderate influence at the structural level (F square = 0.226).

Environmental support in the livestock sector is a factor that has a significant influence on the application of compost management techniques with Path Coefficient (0.442) and P-value (0.000<0.05). Any changes to the environmental support for the livestock sector will increase the application of compost management techniques. In the 95% confidence interval, the influence of environmental support in the livestock sector in expanding the application of compost management techniques is between 0.203 and 0.620. The existence of environmental support in the livestock sector in increasing the application of compost management techniques has a strong influence at the structural level (F square = 0.545). Meanwhile, innovation characteristics do not influence the application of compost management techniques with Path Coefficient (0.189) and P-value (0.225>0.05).

Table 8 – Mediation Test Results

No	Hypothesis	Path Coefficient	P-Value	95 % Confidence Interval Path Coefficient	
				Lower Limit	Upper Limit
1.	Farmer Characteristics -> Innovation Characteristics -> Application of Compost Management Techniques	0.126	0.232	- 0.043	0.369
2.	Environmental Support for the Livestock Sector -> Innovation Characteristics -> Application of Compost Management Techniques	0.054	0.346	-0.020	0.201

Insignificant innovation characteristics act as a mediating variable, namely mediating the indirect influence of farmer characteristics on the application of compost management techniques with a mediation Path Coefficient (0.126) and P-value (0.232>0.05). Likewise, innovation characteristics do not significantly act as a mediating variable in mediating the indirect influence of environmental support in the livestock sector on the application of compost management techniques with a mediation Path Coefficient (0.054) and P-value (0.346>0.05).

PLS is a variance-based SEM analysis that aims to test model theory, which focuses on prediction studies. Therefore, several measures, such as R square and Q square, were developed to indicate that the proposed model was acceptable.

Table 9 – R Square Value

No	Measurement Items	R Square	Q Square
1.	Characteristics of Innovation	0.750	0.741
2.	Application of Compost Management Techniques	0.808	0.797

The statistical size R Square describes the magnitude of variation in endogenous variables that can be explained by other exogenous/endogenous variables in the model. According to Chin (1998), the qualitative interpretation value of R square is 0.19 (low influence), 0.33 (moderate effect), and 0.66 (high power). Based on the data above, it can be stated that the magnitude of the joint influence of farmer characteristics and environmental support on innovation characteristics in the livestock sector is 75.00% (strong force). The importance of the effect of farmer characteristics, ecological support of the livestock sector, and innovation characteristics on compost management techniques is equal to 80.80% (high influence).

Q Square describes a measure of prediction accuracy, namely how well each change in exogenous/endogenous variables can predict endogenous variables. This measure is a form of validity in PLS to state the suitability of model predictions (predictive relevance). A Q Square value above 0 states that the model has predictive relevance; however, in Hair et al. (2019), the qualitative interpretation value of Q Square is 0 (low influence), 0.25 (moderate effect), and 0.50 (high power). Based on the data in Table 8, the Q square value for the innovation characteristic variable is 0.741>0.50 (high prediction accuracy), and the application of compost management techniques is 0.797>0.50 (high prediction accuracy).

CONCLUSION

Applying compost management techniques in Jambi Province is 73% in the medium category. Farmer characteristics and environmental support in the livestock sector directly influence applying compost management techniques in Jambi Province. In contrast, innovation characteristics do not significantly mediate the indirect influence of farmer characteristics and environmental support in the livestock sector on the application of compost management techniques.

ACKNOWLEDGMENTS

Appreciation and thanks to all parties who have contributed to the research and writing of this scientific article, especially to Prof. Dr. Ir. Adriani, MS as Promoter, Dr. Firmansyah, S.Pt., MP, and Dr. Bagus Pramushinto, S.Pt., M.Sc as Co-Promoter who has guided, provided suggestions and input until the completion of writing this article.

REFERENCES

1. Astriku, GE 2020. The Adoption of Agriculture Technology in Small-Scale Farming in the Adumasa Community in Ghana. Agricultural, Food and Environmental Studies. The Hague, The Netherlands.
2. Central Bureau of Statistics. 2021. Jambi in Figures 2020. BPS Jambi Province.
3. Bortamuly AB, Goswami K. 2015 Determinants of modern technology adoption in Assam's handloom industry. Tech Forecast Soc Change 90:400–440.
4. Brown, RC, 2003. Biorenewable Resources-Engineering New Products from Agriculture. Loa state Press, London.
5. Chin, W. 1998. The Partial Least Square Approach To Structural Equation Modelling. Mahwah, New Jersey, USA: Lawrance Erlbaum Associates
6. Dimara, ED Skuras. 2003. Adoption of agricultural innovations as a two-stage partial observability process, Agric. Econ. 28 (3): 187 – 196.
7. Directorate General of Processing and Marketing of Agricultural Products. 2015. Guidelines for Processing Animal Waste (Compost, Liquid Fertilizer, Bio-Urine). Ministry of Agriculture.
8. Gupta, KK, Aneja, KR, Ran, D., 2016. Current status of cow dung as a bioresource for sustainable development. Bioresourc. Bioprocess. 3, 28. https://doi.org/10.1186/s40643-016-0105-9.
9. Hair, J., Black, W., Babin, B., Anderson, R., and Tatham, R., 2006. Multivariate Data Analysis (6th ed.). Upper Saddle River, NJ: Pearson Prentice Hall.
10. Hapsari, U. 2018. The Effect of Aeration and Initial Water Content on Windrow System Cow Manure Composting Performance. Agrinova: Journal of Agricultural Innovation. 1(1), 2018, 008-014.
11. He, Z., 2020. Organic animal farming and comparative studies of conventional and organic manures. In: Waldrip, HM, Pagliari, PH, He, Z. (Eds.), Animal Manure: production, characteristics, environmental concerns, and management. 67, pp. 165 – 182.
12. Huda, S. and Wikanta. 2017. Using Cow Manure Waste into Organic fertilizers to support the Beef Cattle Farming Business in the Mandiri Jaya Livestock Farmers Group, Moropelang Village, Babat District, Lamongan Regency. Journal of Community Service. Vol. 1(1)26-35.
13. Mwangi, M., Kariuki, S., 2015. Factors determining adoption of new agricultural technology by smallholder farmers in developing countries. J. Econ. Sustain. Dev. 6(5).
14. Pantura, A. Setyaningrum, P, Yuwono. 2021. Kinetics of Moisture Content and Percentage of Compost Made from Beef Cattle Feces Enriched by Azolla SpKinetics of Moisture Content and Percentage of Feces Based Compost from Azolla Sp's Fed Cattle. Journal of Animal Science and Technology. 3(1): 74-80.
15. Pierpaoli, E.G. Carli, E. Pignatti, M. Canavari. 2013. Drivers of precision agriculture technologies adoption: a literature review, Procedia Technology 8 (2013) 61 – 69.
16. Pongracz, E., Pohjola, VJ, 2004. Re-dealing waste, the concept of ownership and the role of waste management. Resourc. Conserv. We are recycling 40, 141 – 153.
17. Prihandini, PW and Purwanto, T. 2007. Technical Instructions for Making Compost from Cow Manure. Livestock Research and Development Center. Agriculture department.
18. Rogers, E.M. 2003. Diffusion of innovation. Fifth Edition. New York: Free Press.
19. Suciani, F. Sulistyati, M and S. Alim. 2015. The Relationship Between Internal Factors and External Factors and the Level of Adoption of Biogas Technology among Dairy Cattle

Farmers (Case in the Wargi Saluyu Farmer Group, Haurngombong Village, Pamulihan District, Sumedang Regency). Journals unpad.ac.id. Vol. 4, no. 2. Faculty of Animal Husbandry, Padjadjaran University.

20. Sunarto and Lutojo. 2008. Processing and Production Design of Tanks for Holding and Processing Liquid Organic Fertilizer for Cow Urine Made from Empon-Empon. Voucher Program. DP2M Ministry of National Education Jakarta.
21. Tallou, A., Haouas, A., Jamali, MY, Atif, K., Amir, S., Aziz, F., 2020. Review on cow manure as renewable energy, chapter 17. In: Patnaik, Srikanta, Sen, Siddhartha, Mahmoud, Magdi S. (Eds.), Smart Village Technology Concepts and Developments. Springer, The Netherlands, pp. 341 – 352.
22. Theis, S., Lefore, N., Meinzen-Dick, R., Bryan, E., 2018. What happens after technology adoption? Gendered aspects of small-scale irrigation technologies in Ethiopia, Ghana, and Tanzania. Agric. Hum. 35: 671–684.
23. Yadav, A. Guptaz, R. and Garg, VK 2013. Organic manure production from cow dung and biogas plant slurry by vermicomposting under field conditions. International Journal Of Recycling of Organic Waste in Agriculture 2013. 2013, 2:21 http://www.ijrowa.com/content/2/1/21.
24. Yasmin, N and Grundmann, P. 2019. Adoption and diffusion of renewable energy – The case of biogas as an alternative fuel for cooking in Pakistan. Renewable and Sustainable Energy Reviews 101: 255–264.