RESEARCH
www.commprac.com
ISSN 1462 2815

THE EFFECT OF NATURAL FACTORS, FARMER PERFORMANCE, AND FARMER EVALUATION IN THE IMPLEMENTATION OF GAP FOR VEGETABLE CROPS IN PALOLO DISTRICT, SIGI REGENCY

Arifuddin Lamusa

Department of Agribusiness Faculty of Agriculture, Tadulako University.
Email: lamusa.arif@yahoo.com

DOI: 10.5281/zenodo.13383415

Abstract

This research is an analysis of GAP (Good Agricultural Practices) for vegetable crops, examining various aspects from site selection to post-harvest processes in Palolo District, Sigi Regency. Additionally, this study analyzes factors influencing the adoption of GAP in these vegetable crops. The 'Natural Factors' variable shows a very significant relationship with vegetable crop cultivation, contributing positively and substantially influencing the outcomes of vegetable cultivation, thereby enabling farmers to utilize natural occurrences such as rainfall and seasonal changes that occur annually. The 'Farmer Performance' variable also exhibits a very significant relationship with vegetable cultivation, providing a positive impact and substantial opportunities to add value to vegetable cultivation. This is achieved through the use of leftover vegetable matter as a means to enhance soil humus, thus affecting vegetable production. Apart from these factors, farmers implement various steps in the care of vegetable crops. The research proposal includes suggestions aimed at enhancing farmer participation and interest in vegetable crop cultivation techniques. The proposed improvements for farmers in the Palolo District are as follows: a. Maximizing the use of leftover plant materials as bokashi fertilizer in vegetable gardens to increase the production yields of the vegetables grown in Palolo District. b. Performing weekly evaluations to monitor the progress of the vegetable gardens. c. Each farmer manages different types of organic fertilizers and encourages the community to use leftover vegetable materials as organic fertilizer. d. Providing instructions to farming groups, such as conducting outreach and weekly evaluations of the cultivated vegetable plants.

Keywords: SEM-AMOS, Vegetable Crops, Farmer Performance, Crop Cultivation Techniques.

1. INTRODUCTION

Good Agricultural Practices (GAP) represent a certification system essential for cultivating crops according to established standards aimed at producing high-quality agricultural products Farmers, as producers, must adhere to one of the certification systems known as Good Agricultural Practices, or GAP[1], [2] According to the Ministry of Agriculture of the Republic of Indonesia, GAP entails a technical application of the certification process in agricultural production that utilizes environmentally friendly and sustainable advanced technology. Consequently, the harvested products are safe for consumption, the welfare of workers is considered, and farming provides economic benefits to farmers[2], [3]

In the Palolo District, vegetable crops, which are perennial and always cultivated by farmers, serve as sources of vitamins, mineral salts, and other nutrients[4], [5] These nutrients are consumed from parts of the plant such as leaves and/or fruits that are more than a year old, including vegetables, fruits, bio-pharmaceutical plants, and ornamental plants harvested during the reporting period (BPS Sigi Regency).

The harvesting area for vegetable crops includes areas that are harvested all at once/completely/dismantled and areas harvested multiple times (more than once)/not completely harvested:

A. Crops harvested all at once/completely/dismantled include crops that are emoved or uprooted immediately after harvest, consisting of red onions, garlic, scallions, potatoes, cabbage, cauliflower, Chinese cabbage, carrots, radishes, and red beans.

B. Crops harvested multiple times/not completely harvested include crops harvested more than once, usually dismantled when the last harvest is no longer sufficient, consisting of long beans, large chili, bird's eye chili, mushrooms, tomatoes, eggplants, green beans, cucumbers, chayote, water spinach, spinach, melon, watermelon, and cantaloupe.

Palolo District, divided into four dominant vegetable-producing villages within Sigi Regency, includes Sigimpu Village, Bunga Village, and Kapiroe Village[6], [7]The dominant vegetables produced are red onions, chili, tomatoes, potatoes, cabbage, and Chinese cabbage, among others, with productivity ranging from 200kg to 800kg.

The vegetable production from these three districts serves as the primary supplier for vegetable needs in the Central Sulawesi province and even extends to international markets. Given this reality, comprehensive information related to the implementation of GAP at the farmer level as producers is crucial, as no studies have yet explored the GAP approach for vegetables in Palolo District, Sigi Regency.

Research on the implementation of GAP on agricultural commodities has been widely conducted, such as studies showing the implementation of GAP in horticultural crops[8], [9]. Additionally, most research on GAP implementation focuses solely on cultivation aspects. In this study, an analysis of GAP in vegetable crops is conducted by examining various aspects, from site selection to post-harvest. Furthermore, this study also analyzes factors influencing the adoption of GAPin the sevegetable crops [10],[11].

Research on GAP implementation in agricultural commodities such as horticultural and food crops, including rice in various regions in Indonesia, is still considered to be in a low category[12], [13] Besides, research on GAP implementation is mostly done by only looking at cultivation aspects. In this study, an analysis of GAP on vegetable crops is carried out by looking at various aspects from site selection to post-harvest.

Moreover, this study also involves an analysis of the factors influencing the adoption of GAP in vegetable crops[1], [14] Below is a chart depicting farmers' responses to Vegetable Crop Cultivation Techniques (VCT) in the Palolo Area, as shown in Figure 1.

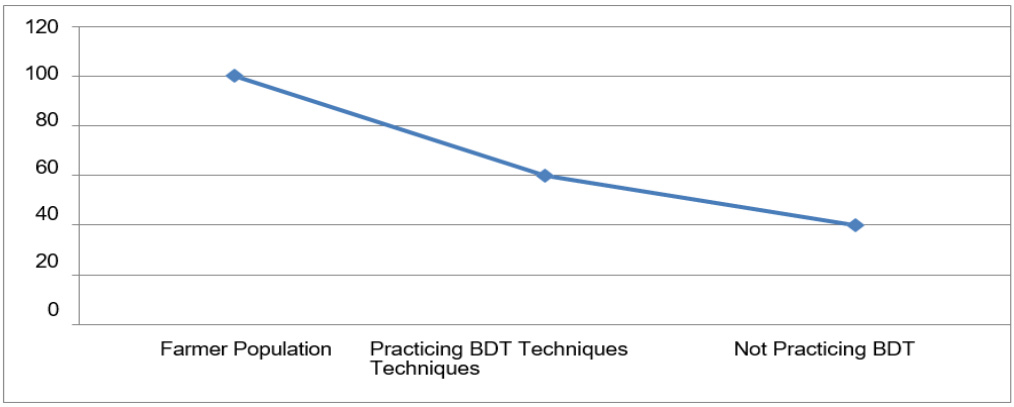

Figure: 1

Source: Data processed in Excel software,

According to Figure 1, out of 100 respondents, 40 farmers (40%) do not practice VCT, while 60 farmers (60%) do. This indicates that a majority of farmers in the Palolo area of Sigi District have not adopted Vegetable Crop Cultivation Techniques. Based on the background described above, the author is interested in conducting a study applying SEM-AMOS to determine the impact of Natural Factors and Farmer Performance on the VCT in Palolo District, Sigi Regency.

2. RESEARCH METHODOLOGY

The research methodology involves the steps undertaken in conducting the study. The stages are depicted in figure 2.

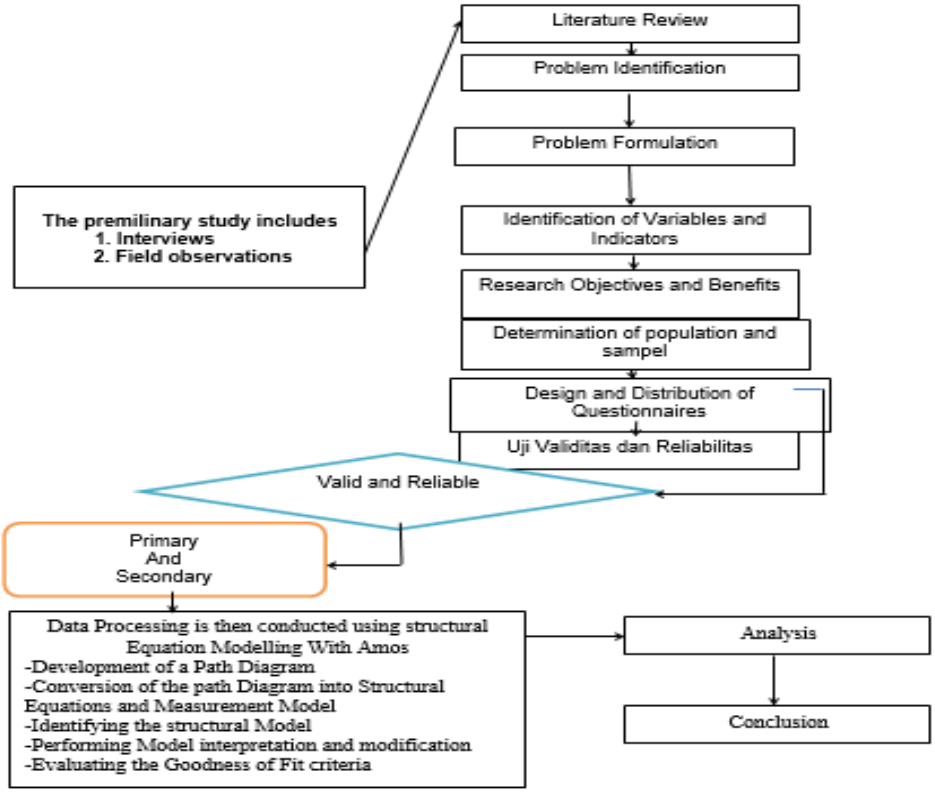

Figure 2: Research Methodolgy Flowchart

3. RESULTS AND DISCUSSION

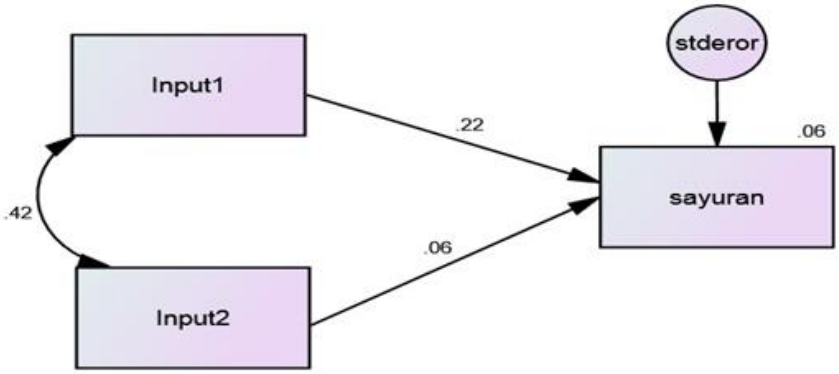

Figure 3: Conceptual Model

In Figure 3, the conceptual model generally consists of two independent variables and one dependent variable. The independent variables are community knowledge, community attitudes, and community actions, while the dependent variable is the Vegetable Crop Cultivation Techniques (VCT).

3.1 Path Diagram Development

The theoretical model previously established is depicted in a path diagram to facilitate the researcher's examination of the causal relationships intended for testing[15], [16] A path diagram is a visual representation of a model that illustrates all relationships among the variables included within it. The development of the path diagram can be seen in the following figure:

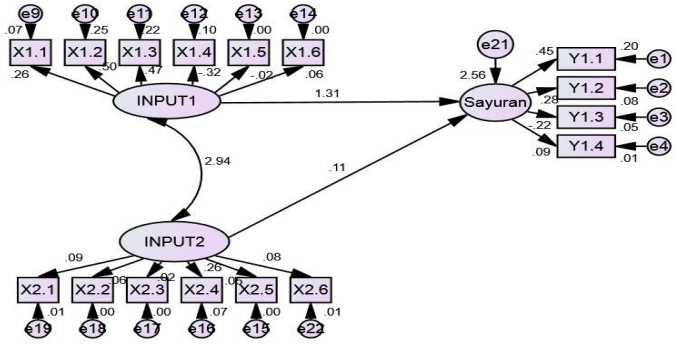

Figure 4: SEM Model

3.2 Conversion of Path Diagram to Structural Equations and Measurement Model

1. Structural Equation

The structural equation in this study is:

Actions on Vegetable Crops = β1 Natural Factors + β2 Farmer Performance + β3 Vegetable Crops + Z1

2. Measurement Model

The measurement model for this study is: Table 4.1 Measurement Model of Exogenous Concept (Natural Factors)

Table 1: Measurement Model of Exogenous Concept (Natural Factors)

Exogenous Concept
X1 = λ1 Natural Factors + e1
X2 = λ2 Natural Factors + e2
X3 = λ3 Natural Factors + e3
X4 = λ4 Natural Factors + e4
X5 = λ5 Natural Factors + e5
X6 = λ6 Natural Factors + e6

(Source: Data Processing, 2023)

Table 2: Measurement Model of Exogenous Concept (Vegetable Cultivation Techniques)

Exogenous Concept
SX1 = λ1 Farmer Performance + e7
X2 = λ2 Farmer Performance + e8
X3 = λ3 Farmer Performance + e9
X4 = λ4 Farmer Performance + e10
X5 = λ5 Farmer Performance + e11
X6 = λ6 Farmer Performance + e12

(Source: Data Processing, 2023)

Below is the table for the measurement of the endogenous concept (Presence of Waste Management House):

Table 3: Measurement Model of Endogenous Concept (Impact on Vegetable Crops)

Endogenous Concept
Y1 = λ1 VCT Techniques + e13
Y2 = λ2 VCT Techniques + e14
Y3 = λ3 VCT Techniques + e15

(Source: Data Processing, 2023)

A number of distinct sample moments:	100
Number of distinct parameters to be estimated:	60
Degrees of freedom (100 - 60):	40

Degrees of Freedom of the Initial Model

Since the degrees of freedom (df) value is positive, the model is overidentified, and testing on the model can be conducted.

3.3 Interpreting and Modifying the Model

Model modification aims to assess whether the adjustments can reduce the chi-square value. As it is known, a smaller chi-square value indicates a better fit of the model to the data. An indicator shows significant convergent validity if it has a critical ratio greater than 2. This indicates that the indicators used validly measure what they are supposed to in the model.

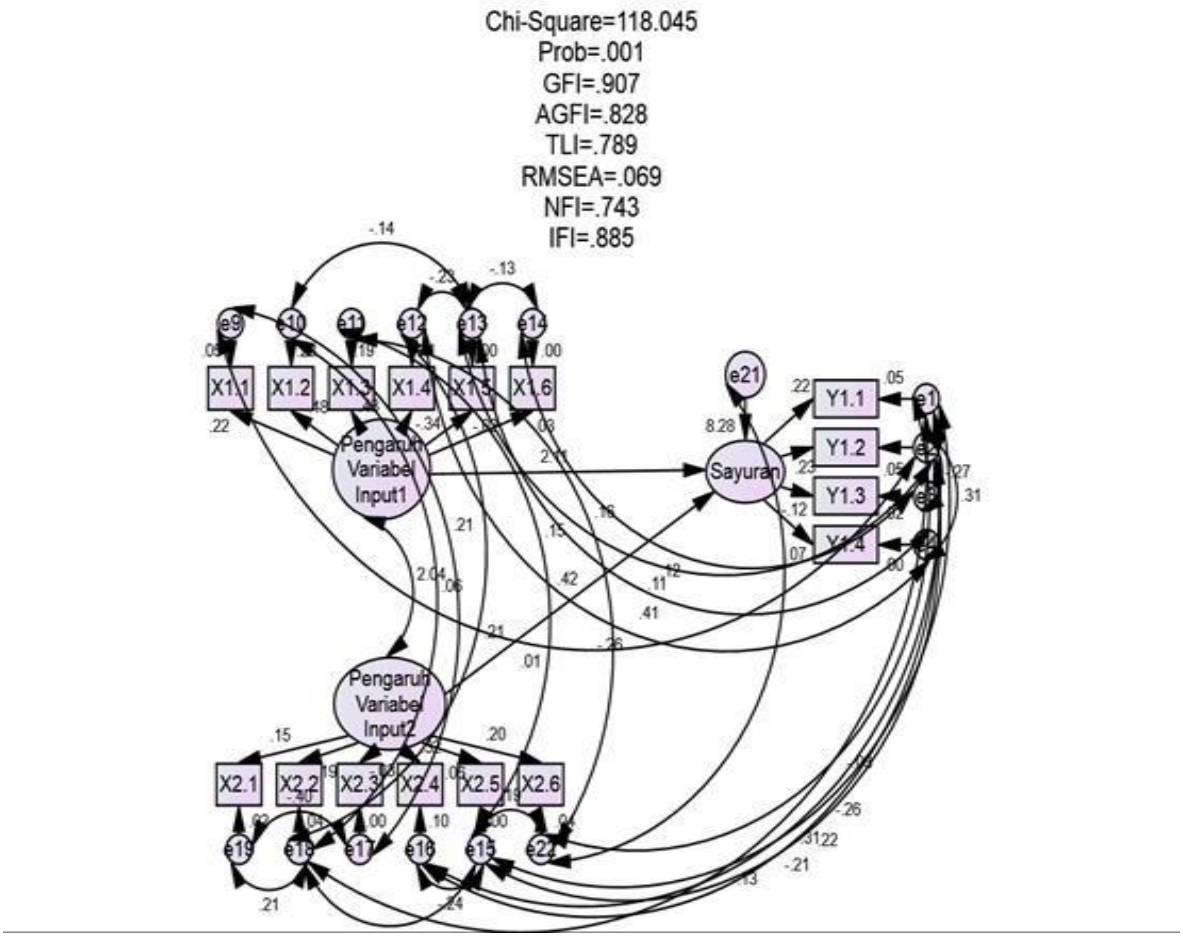

Figure 5: SEM Model After Modification

Figure 5. shows the SEM model after modification, noting that the chi-square value after modification is 118.045, while the chi-square value before modification was 975.456. This means the chi-square value has decreased from the previous value.

Table 4: Regression Weights

			Estimate	S.E.	C.R.	P	Label
X1.3	←	INPUT1	2.256	1.094	2.062	.039	par_5
X1.4	←	INPUT1	-1.681	.935	-1.798	. ***	par_6
X1.5	←	INPUT1	-.125	.617	-.203	***	par_7
X1.6	←	INPUT1	.183	.811	.226	. ***	par_8
X2.5	←	INPUT2	1.000				
X2.4	←	INPUT2	1.974	2.894	.682	. ***	par_9
X2.3	←	INPUT2	-.048	.128	-.377	***	par_10
X2.2	←	INPUT2	1.033	1.470	.702	***	par_11
X2.1	←	INPUT2	1.102	1.566	.704	.482	par_12
X2.6	←	INPUT2	2.450	3.232	.758	. ***	par_14

(Source: Primary Data Processing, 2023)

From the regression weights, as shown in Figure 5 above, it is evident that all indicators are significant, marked by a critical ratio greater than 2, and P-values below 0.005.

3.4 Evaluation of Goodness of Fit Criteria

The model evaluation was conducted through suitability tests, statistical tests, and reliability tests[17], [18] Suitability and statistical tests were performed using various Fit Indices to measure the accuracy of the proposed model[19], [20] The evaluation results for each modified model are compared against the statistical thresholds established in the SEM procedures. The Goodness of Fit Indexes results for this study are as follows

Table 5: Recapitulation of Goodness of Fit Evaluation

Criteria	*Cut-off Value*	Result	Evaluation
Chi-Square	Expected Small	118.045	Adequate (Fit)
Signifikan Probability	<0.05	0.001	Good (Fit)
RMSEA	< 0.08	0.069	Good (Fit)
GFI	<0.9	0.828	Good (Fit)
TLI	> 0.95	0.789	Adequate (Fit)
NFI	Close to 1	0.743	Good (Fit)
IFI	>0.9	0.885	Adequate (Fit)

(Source: Primary Data Processing, 2023)

Based on Table 4.5, it is noted that the Goodness of Fit Indexes for this research model meet all criteria well; thus, it can be concluded that the model is consistent with the observed data and the existing field conditions.

3.5 SEM Method Testing Results

This hypothesis testing was conducted to determine whether exogenous variables significantly influence endogenous variables. A hypothesis is accepted if the probability value is P < 0.05 and the Critical Ratio (CR) is greater than 1.96. Table 4.6 presents the Regression Weights Estimates from AMOS 20 software.

	C.R	P
Vegetable Crop Cultivation Techniques – Natural Factors	2.467	.003
Vegetable Crop Cultivation Techniques – Farmer Performance	2.492	.002

(Source: Data Processing, 2023)

Decision Basis:

If the Probability (P) value > 0.05, then H0 is accepted and H1 is rejected. If the Probability (P) value < 0.05, then H_0 is rejected and H_1 is accepted.

Based on Table 4.6, the results of the hypothesis testing are as follows:

1. For Vegetable Crop Cultivation Techniques (VCT) – Natural Factors, it is observed that the P value of 0.001 < 0.05. This value is significantly below 0.05, thus H1 is accepted. Therefore, it can be stated that there is a positive and significant influence of Natural Factors on Vegetable Crop Cultivation Techniques.
2. For Vegetable Crop Cultivation Techniques (VCT) – Farmer Performance, it is observed that the P value of 0.000 < 0.05. This value is significantly below 0.05, thus H1 is accepted. Therefore, it can be stated that there is a positive and significant influence of Farmer Performance on Vegetable Crop Cultivation Techniques.

3.6 Theoretical Model Development Analysis

The development of a model based on theoretical considerations aims to examine the interrelationships among variables t heoretically[21], [22] In this study, three variables with 15 indicators were identified, where each variable has six indicators for Variable Input 1 and Variable Input 2, and three indicators for Variable Output. Although in reality there are numerous factors that affect these variables and indicators, it is expected that the selected factors adequately represent the actual conditions in the field.

3.7 Path Diagram Development Analysis

After establishing connections between independent and dependent variables, the causal relationships between each variable and indicators to variable constructs can be observed. Each construct or indicator is assigned an error value, which serves to allow for error tolerance that might occur[17], [18]These errors or deviations could be due to indicators not fully representing or reflecting the real conditions in the field.

In the model, many "1" values appear, which automatically emerge when adding an error variable. Thus, all error variables are assigned a predetermined or fixed parameter value of 1.

3.8 Conversion of Path Diagram to Structural Equations and Measurement Model Analysis

1. Structural Equation

The structural equation for Vegetable Crop Cultivation Techniques (VCT) is:

= β1 Natural Factors + β2 Farmer Performance + β3 Vegetable Crop Cultivation Techniques + Z1. This structural equation includes the constants β1 and β2 from the Natural Factors and Farmer Performance variables, which consistently influence the variable β3 Vegetable Crop Cultivation Techniques. The inclusion of an error value also influences the results, although this error value is primarily an anticipatory step or tolerance for potential deviations or errors as mentioned above.

2. Measurement Model Equation

The purpose of the measurement model equation is to examine the extent of the relationship between variables and their respective indicators, eventually viewed based on their output, for instance, equation X1 = λ1 Natural Factors + e9. This equation expresses the relationship between the variable Natural Factors (input1), where the magnitude of λ in the equation will also affect decision-making and understanding how this relationship value progresses through several stages.

3.9 Model Interpretation and Modification Analysis

Model modification is performed by linking error levels as indicated by the output from AMOS software[23], [24] Modifications are made to facilitate adjustments based on Modification indices. The function is to simplify the modification of the SEM model so that it aligns with the previously created SEM model. For example, linking e15 to e9 reduces the chi-square value in the modified SEM model. After

modification, the chi-square value decreased by 487.037 from 975.458, indicating that the chi-square value after modification is smaller or reduced from before.

Based on the Regression Weights output after modification, all indicators are now in the valid or significant category, leading to the conclusion that the significant indicators mean respondents understand and comprehend the statements presented in the questionnaire.

3.9.1 Goodness of Fit Criteria Analysis

This analysis of the goodness of fit criteria will examine values such as chi-square, probability, df, CMIN/DF, GFI, TLI, IFI, RMSEA, and NFI. The chi-square value represents the level or condition of the research conducted. All these test results indicate a good fit.

4. CONCLUSION

Based on the research and data analysis, the following conclusions can be drawn:

1. The variable Natural Factors has a highly significant relationship with Vegetable Crop Cultivation. These natural factors contribute positively and have a substantial influence on the outcomes of vegetable cultivation, thus farmers consistently utilize natural occurrences such as rainfall and seasonal changes that occur annually.
2. The variable Farmer Performance also shows a highly significant relationship with Vegetable Crop Cultivation. Farmer Performance provides a positive impact and significantly enhances the added value in vegetable cultivation. This is due to the use of leftover vegetable matter as a means to increase soil humus, thereby affecting vegetable production. In addition to these factors, farmers take various steps in the care of vegetable crops.
3. The proposed design improvements in this research aim to enhance farmer participation and interest in Vegetable Crop Cultivation Techniques (VCT). The suggested improvements for farmers in the Palolo District are as follows:
    a. Maximize the use of plant residues by converting them into bokashi fertilizer for vegetable gardens to improve the production yields of vegetables in Palolo District, Sigi Regency.
    b. Conduct weekly evaluations to monitor the progress of the vegetable gardens.
    c. Each farmer should manage different types of organic fertilizers and encourage the community to use leftover vegetable materials as organic fertilizer.
    d. Provide instructions to farming groups, such as conducting outreach and weekly evaluations of the cultivated vegetable plants.

References

1) G. C. Schoneveld *et al.*, “Certification, good agricultural practice and smallholder heterogeneity: Differentiated pathways for resolving compliance gaps in the Indonesian oil palm sector,” *Glob. Environ. Change*, vol. 57, p. 101933, Jul. 2019, doi: 10.1016/j.gloenvcha.2019.101933.

2) R. Zhou *et al.*, “Environmental changes impact on vegetables physiology and nutrition – Gaps between vegetable and cereal crops,” *Sci. Total Environ.*, vol. 933, p. 173180, Jul. 2024, doi: 10.1016/j.scitotenv.2024.173180.

3) A. C. A. Sheyoputri and A. Abri, “Analisis Struktur Pasar Sayuran di Desa Kanreapia Kecamatan Tinggimoncong Kabupaten Gowa Provinsi Sulawesi Selatan,” *J. Ilm. Ecosyst.*, vol. 21, no. 3, pp. 634–643, Dec. 2021, doi: 10.35965/eco.v21i3.1251.

4) A. C. Falcone, M. L. Zonta, J. M. Unzaga, and G. T. Navone, “Agricultural practices and intestinal parasites: A study of socio-environmental risk factors associated with leafy vegetable production in La Plata horticultural area, Argentina,” *Parasite Epidemiol. Control*, vol. 23, p. e00327, Nov. 2023, doi: 10.1016/j.parepi.2023.e00327.

5) J. A. Mbanasor *et al.*, “Climate smart agriculture practices by crop farmers: Evidence from south east Nigeria,” *Smart Agric. Technol.*, vol. 8, p. 100494, Aug. 2024, doi: 10.1016/j.atech.2024.100494.

6) A. Munir, S. Sureshwaran, H. M. G. Selassie, and J. C. O. Nyankori, “An Analysis of Market Integration for Selected Vegetables in Indonesia,” *J. Agro Ekon.*, vol. 16, no. 1–2, p. 1, Sep. 2016, doi: 10.21082/jae.v16n1-2.1997.1-12.

7) M. Rahman Khan, T. F. Rizvi, and M. S. Anwar Ansari, “Nematode problems in vegetables and ornamentals under protected cultivation and their sustainable management,” in *Nematode Diseases of Crops and their Sustainable Management*, Elsevier, 2023, pp. 685–706. doi: 10.1016/B978-0-323-91226-6.00002-X.

8) T. Emura and Y. Konno, “A goodness-of-fit test for parametric models based on dependently truncated data,” *Comput. Stat. Data Anal.*, vol. 56, no. 7, pp. 2237–2250, Jul. 2012, doi: 10.1016/j.csda.2011.12.022.

9) J. B. A. Oduol *et al.*, “Women’s participation in high value agricultural commodity chains in Kenya: Strategies for closing the gender gap,” *J. Rural Stud.*, vol. 50, pp. 228–239, Feb. 2017, doi: 10.1016/j.jrurstud.2017.01.005.

10) M. Bonato, O. Cepni, R. Gupta, and C. Pierdzioch, “Financial stress and realized volatility: The case of agricultural commodities,” *Res. Int. Bus. Finance*, vol. 71, p. 102442, Aug. 2024, doi: 10.1016/j.ribaf.2024.102442.

11) B. Dahal, C. Kimmerer, and G. Hailu, “Value added to agricultural commodities,” in *Future Food Systems*, Elsevier, 2024, pp. 89–107. doi: 10.1016/B978-0-443-15690-8.00010-2.

12) H. Mayrowani, “Pengembangan Pertanian Organik di Indonesia,” *Forum Penelit. Agro Ekon.*, vol. 30, no. 2, p. 91, Aug. 2016, doi: 10.21082/fae.v30n2.2012.91-108.

13) X. Xu *et al.*, “Optimizing organic fertilization towards sustainable vegetable production evaluated by long-term field measurement and multi-level fuzzy comprehensive model,” *Agric. Ecosyst. Environ.*, vol. 368, p. 109008, Jul. 2024, doi: 10.1016/j.agee.2024.109008.

14) A. Manzoor *et al.*, “Vermicompost: A potential organic fertilizer for sustainable vegetable cultivation,” *Sci. Hortic.*, vol. 336, p. 113443, Oct. 2024, doi: 10.1016/j.scienta.2024.113443.

15) A. Pal, J. P. Singh, and P. Dutta, “Path length prediction in MANET under AODV routing: Comparative analysis of ARIMA and MLP model,” *Egypt. Inform. J.*, vol. 16, no. 1, pp. 103–111, Mar. 2015, doi: 10.1016/j.eij.2015.01.001.

16) G. Woleba, T. Tadiwos, E. Bojago, and M. Senapathy, “Household food security, determinants and coping strategies among small-scale farmers in Kedida Gamela district, Southern Ethiopia,” *J. Agric. Food Res.*, vol. 12, p. 100597, Jun. 2023, doi: 10.1016/j.jafr.2023.100597.

17) D. Althoff and L. N. Rodrigues, “Goodness-of-fit criteria for hydrological models: Model calibration and performance assessment,” *J. Hydrol.*, vol. 600, p. 126674, Sep. 2021, doi: 10.1016/j.jhydrol.2021.126674.

18) V. Totaro, G. Kuczera, and V. Iacobellis, “Goodness-of-fit, identifiability and extrapolation: Can the two-component extreme value distribution be used in at-site flood frequency analysis?,” *J. Hydrol.*, p. 131590, Jul. 2024, doi: 10.1016/j.jhydrol.2024.131590.

19) M. Cavicchioli, “Goodness-of-fit tests for Markov Switching VAR models using spectral analysis,” *J. Stat. Plan. Inference*, vol. 219, pp. 189–203, Jul. 2022, doi: 10.1016/j.jspi.2021.12.008.

20) C. Watanabe and T. Suzuki, “Goodness-of-fit test for latent block models,” *Comput. Stat. Data Anal.*, vol. 154, p. 107090, Feb. 2021, doi: 10.1016/j.csda.2020.107090.

21) H. Bonakdari and M. Zeynoddin, “Goodness-of-fit & precision criteria,” in *Stochastic Modeling*, Elsevier, 2022, pp. 187–264. doi: 10.1016/B978-0-323-91748-3.00003-3.

22) A. Maydeu-Olivares, D. Shi, G. Pavlov, and R. Ferraz, “Model-data fit evaluation: item fit and model selection,” in *International Encyclopedia of Education(Fourth Edition)*, Elsevier, 2023, pp. 260–272. doi: 10.1016/B978-0-12-818630-5.10036-3.

23) J. C. Bustamante and E. Chacón, “Estimation and goodness-of-fit in latent trait models: A comparison among theoretical approaches,” *Stat. Methodol.*, vol. 33, pp. 83–95, Dec. 2016, doi: 10.1016/j.stamet.2016.05.002.

24) D. C. Jupiter, “Snug as a Bug: Goodness of Fit and Quality of Models,” *J. Foot Ankle Surg.*, vol. 56, no. 6, pp. 1357–1360, Nov. 2017, doi: 10.1053/j.jfas.2017.08.001.