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Determinant of Women Farmers' Participation in Agricultural Environmental Management in Kupang, East Nusa Tenggara, Indonesia

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ABSTRACT

Background: The management of agricultural environmental (AEM) is directed towards the goal of a healthy and sustainable environment and supports long-term household food security. The study was conducted from May to October 2024. The objectives were to find out : farming characteristic, agricultural environmental management and the factors that influence Women Farmers to participate in AEM.

Methods: A quantitative method to analyze the relationship between multiple variables and the Ordinal Regression test used for modeling the determinant of women farmers' participation in agricultural environmental management. Data collection was carried out with 1. A qualitative approach with interview techniques to research respondents. 2. A quantitative approach, using questionnaires and Cross Tabulation Analysis. The research location was chosen purposively, considering the population who own agricultural land and work as farmers. The sample was determined using the stratified proportion random sampling technique.

Result: Farming carried out by farmers is dry land farming; management of the agricultural environment is generally still carried out with a traditional agricultural system and still relies on the use of chemical fertilizers, pesticides and chemical herbicides; and Participation of Women in AEM is included in the moderate category with an average score of 27.71 determinant of women participation in AEM are: age, education, family size, land area, farming experience and membership of farmer groups.

Key words: Agricultural environment, Management, Participation, Women.

INTRODUCTION

Agricultural environmental management needs to involve women as farmer partners and is expected to increase productivity, increase profits and food security. This study is based on a framework of thinking that women as farmer partners in running a farming business, have a role in the family economy (Amponsah *et al*., 2023; Brief, 2020). In this publication, it is also stated that women in the developing cuontries comprise 43% of the agricultural workforce. and 2/3 of the 600 million livestock farmers in the world. It is also known that 50 per cent of Indonesia's population are women, 61 per cent of rural women are involved in the agricultural sector with a female workforce participation rate of 39 per cent. Agricultural environmental management is directed towards the goal of a healthy and sustainable environment and supports long-term agricultural development (Ernantje *et al*., 2021), for this reason, active participation from farmers and female farmers is needed. Furthermore, the empowerment of rural women farmers extends to social and environmental issues. Studies show that women have greater control over household management and that women farmers often have a deeper understanding of their local ecosystems and are more likely to adopt sustainable practices that maintain soil fertility and biodiversity (Malo *et al*., 2023; Rachna, 2022; Tsoeu *et al*., 2024).

Kupang Regency with total area 5.298,13 km^2 is located between -9015′ 11,78″ - 10022 14,25″ South Latitude and between 123016′ 10,66″ - 124013′ 42,15″ East Longitudes, with a population in 2024 of 390.210 people, consisting of 197.900 men and 192,310 women, spread across 77,484 families, of which 70% live from farming and most are dry land farmers or field farmers (BPS Kabupaten Kupang, 2022).

Based on the Food and Agriculture Organization of the United Nations (FAO) publication, 2021, which states that in the developing countries, farmers as food producers, women and children in rural areas are included in the vulnerable category during the Covid-19 pandemic. The population of Kupang Regency, 70% work as farmers and from the results of previous studies it is known that participation in environmentally friendly activities is classified as low-moderate 88.03% (33.33% at a low

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participation level, 54.70% is classified as a moderate participation level) and a high participation rate of only 11.97%. Thus, to support the sustainability of agricultural development, active participation of farmers and women farmers is needed as partners in managing the agricultural environment to increase agricultural production.

The concept of sustainable agricultural environmental management is a way to maintain environmental sustainability (Ernantje, 2019). Agricultural Environmental Management (AEM) can be:

1. Paying attention to good physical, chemical and biological properties of the soil.
2. Paying attention to soil management methods that reduce erosion.
3. Increasing the organic matter content of the soil and encouraging the quantity and diversity of soil biology (Dev *et al*., 2023; Ernantje, 2019; Maurya *et al*., 2020).

In organic farming for soil fertility, the following techniques are used (Das *et al*., 2025; Hariraj *et al*., 2025; Kumar, 2024; Luttikholt, 2021).

1. Integration of crops with livestock, mixed planting and proper crop rotation.
2. Use of organic fertilizers to increase the population of soil microorganisms.
3. Minimizing processing before use.
4. Not using chemical fertilizers and synthetic pesticides.
5. Reducing the amount of waste by recycling waste into organic fertilizer is an environmentally friendly agricultural practice (Hendrik *et al*., 2025).

Animal waste, straw and other agricultural waste that have been considered waste have actually become materials that have value as a source of nutrients and organic materials for organic farming (Shams *et al*., 2017; Wasil *et al*., 2022; Yali and Begna, 2022). The results of Hendrik *et al*., 2021 research in Kupang, found that the agricultural environmental management average score was 16.80 or the category "Moderate" with a range of 13-23, the farming run by respondents were characterized by dry land farming, yards, rainfed rice fields and mixed farming or Mamar (traditional agroforestry), pest and weed management using pesticide and herbicide which will affect soil condition (Panda and Sharma, 2025; Yadav *et al*., 2024).

Participation of women farmers

Women farmers have an important role in economic development, both through paid agricultural work and through traditional work that is useful in the household and in the community (Amponsah *et al*., 2023; Rachna, 2022). The development of sustainable farming systems need to pay attention to increasing the capabilities and roles of women (Abiala and Ojo, 2019; Patil and Babus, 2018). Some roles of women in agriculture and demographic trends in rural areas are as follows:

1. Economically active population in agriculture.
2. Time spent in agricultural activities.

One of the most important components of the environmental impact assessment process is community participation in decision-making (Abiala and Ojo, 2019; Patil and Babus, 2018; Quisumbing *et al*., 2023). There are several levels of community participation:

1. Informing the community about decisions implies the lowest level of participation.
2. Involving the community in decision making at various levels is a higher level of participation.
3. The highest level of participation depicts close collaboration at all levels of decision-making with the community.
4. Lastly, placing decision-making in the hands of the community means empowerment.

MATERIALS AND METHODS

The area of study

This research was conducted over a period of 6 months, from May 2024 to Oktober 2024, in Kupang Regency, NTT. Agriculture characterized by dry land is the main livelihood source for the community, especially in rural areas. The Central Bureau of Statistics of Kupang (BPS Kabupaten Kupang, 2022) recorded that the area of agricultural land in Kupang was 93.48% dry land and 6.52% rice fields (wet areas). For the agricultural production sustainability, environmentally friendly farming management is needed. However, research results show that farmers generally still rely on the use of chemical fertilizers and pesticides that are not environmentally friendly, crop residues are generally left to dry in the fields and then burned (Ernantje, 2019; Leitner and Vogl, 2020).The research location was chosen purposively considering the population who own agricultural land and work as farmers 66.189 houholds of the total population), 36.870 household are small farmers, with an average land area owned of less than 0.5 ha.

Sampilng and data collection

Questionnaires and documentary sources data collection was conducted through in-depth interviews. For empirical analysis, primary and secondary data are two sets used. Primary data were collected through field questionnaire administration and interviews while secondary data were obtained from related institutions and literature search. One set of questionnaires was administered to interview 82 farmers. Information collected through questionnaires included farmer characteristics such as age, gender, education level, household size, farming experience, land size, farmer group membership, farm characteristics and management. The target population was rural farmers the sample size was 82 farmers from rural areas who were previously involved in rural FGD research on AEM.

Female farmer participation score

Is the total score of participation in AEM, measured based on respondents' answers to the question items. Each question is given a score of 1 to 4. Participation in AEM is categorized into three categories: High, Moderate, Low., based on the results of the maximum score and minimum score The score is calculated based on women's

participation in agricultural environmental management categorized as follows:
X< Mean - sd: Low.
Mean-sd< X < Mean + sd: Moderate.
X ≥ Mean + sd: High.

Ordinal regression

It is a statistical method of ordinal regression analysis that can describe the relationship between one variable response (Y) and more than one variables predictor (X). and measurement scale is in the form of levels or rankings (Entries, 2020; Gambarota, 2024). The formula used in ordinal regression is:

$$\text{Log}\,[P\,(Y \leq j)/(1 - P\,(Y \leq j)] = \alpha_j + \beta_1X_1 + \beta_2X_2 + \ldots + \beta_pX_p$$

P(Y ≤ j) = The cumulative probability of the dependent variable (Y) being in category (j) or lower.
(α_j) = The intercept term specific to category (j).
(β_1, β _2, ….., β _p) = The regression coefficients associatd with each predictor variable (X_1, X_2,…., X_p).
(X_1, X_2, …, X_p) = The predictor variables used in the analysis.

The hypotheses to be tested in this study are: H0, between the predictor variables with probability of a certain category or lower on the ordinal scale there is no significant impact and Alternative Hypothesis H1: between the predictor variables with probability of a certain category, there is significant impact.

Multicollinearity test

In ordinal regression testing, the problem of multicollinearity needs to be investigated because if there is multicollinearity it will interfere with the significance of the independent variables (Daoud, 2017; Senaviratna and Cooray, 2019), it will cause difficulty in determining the existing influence from which variable then the p-value of the regression coefficient can no longer be interpreted, if there is a correlation between independent variables A sign of multicollinearity between independent variables is if one independent variable can represent one other independent variable well.

$$\hat{y} = b_1x_1 + b_2x_2 + \ldots\ldots + b_kx_k + a \quad \ldots(1)$$

$$\hat{x}_1 = b_2x_2 + \ldots\ldots + b_kx_k + a \quad \ldots(2)$$

$$\hat{X}_2 = b_2x_2 + \ldots\ldots + b_kx_k + a \quad \ldots(3)$$

$$\hat{X}_k = b_1x_1 + b_2x_2 + \ldots\ldots\ldots + a \quad \ldots(4)$$

It can be seen that the regression model cannot know what *b1* or what the other coefficients are, where x1 can consist entirely of other variables.

Tolerance value

The tolerance of individual predictors is considered to determine whether multicollinearity occurs. The tolerance Ti for predictor i. is calculated by:

$$Ti = 1 - R_i^2$$

Test results with a T value < 0.1 are considered critical and multicollinearity occurs, which means that more than 90% can be explained by other predictors.

VIF multicollinearity

Variance Inflation Factor (VIF) can also used to measure multicollinearity is the. The VIF statistic is calculated by:

$$VIFi = 1/1 - R_i^2$$

Test results with a VIF value > 10 are considered critical and multicollinearity occurs, the higher the VIF value will increase, the more multicollinearity will occur.

RESULTS AND DISCUSSION

Respondent characteristics

The respondents average age was 58 years with range between 23-81 years. Meanwhile, the education level of the respondents (Table 1) consisted of 2 respondent from higher education, 31 respondents from high school, 14 respondents from junior high school and 35 respondents from elementary school. The average number of dependents in the family was 4 people, with a range between 1-5 people. as shown in the following table.

Characteristics of farming

Wetland or paddy field farming and dryland farming are farming patterns carried out by respondents, rice, corn, beans and vegetables are generally planted with intercropping patterns, where two or more types of plants planted on the same land at the same time without different

Table 1: Respondent characteristics.

Respondent characteristics	Number of respondent	Percentage	Mean
1. Age			
15-55	57	69.51	51.96
≥56		30.49	
2. Educations	25		
Elementary schools		42.68	2.00
Junior high schools	35	17.07	
High schools	14	37.81	
University	31	2.44	
3. Family size	2		
2-4		78.05	2.73
≥4	64	21.95	
4. Farming experience	18		
<5		1.20	27.06
5-10	1	7.30	
>10	6	91.50	
5. Farmers group member	75		
Yes		47.56	0.46
No		52.44	
	39		
	43		

row arrangements. The types of plants cultivated are rice, corn, cassava, vegetables, long beans, peanuts, papaya, bananas, coconuts, cashew nuts. In addition, to planting with an intercropping planting pattern, raising livestock is also carried out by respondents, this pattern provides various products that are sufficient to feed family members in households with small land size.

The smallest land owned by respondents is 2 acre and the largest is 171 acre with an average land ownership of 24,61 acre. From the data, the area of land owned by respondents can be categorized as narrow land (Table 2). Based on land size, the distribution of respondents is as in the following table.

Women farmers participation in agricultural management

The average participation score of women farmers is 27.62 or participation is included in the "moderate" category, with the lowest score being 17 and the highest being 37. The respondents distribution based on the score of women's participation in agricultural management is as in the following table.

From the results above (Table 3), it can be seen that 12 respondents (14.63%) fall into the low participation category, 55 respondents (67.07%) have moderate participation, 15 respondents (18.29%) have high participation. The women farmers participation is low, especially activities in land processing, eradicating pests and diseases, as well as sorting and cleaning after harvest. High women's participation is shown, especially in marketing activities for agricultural products (70% of respondents' opinion) and seed preparation (50% of respondents' opinion).

Deciding what type of plant to cultivate, in answering the question who makes the decision on what type of plant to plant or cultivate, 18 respondents (34.62%) stated that the decision was made by female farmers, 23 respondents (44.223%) stated that female farmers made decisions involving children, 82 respondents (100%) stated that women were not involved in land processing and eradicating pests and diseases. 19 respondents (36.54%) stated that land processing was carried out by men and 22 respondents (42.31%) stated that land processing was carried out by men and children, 2 respondents (3.85%) stated that it was decided by men and women and 6 respondents (11.54%) stated that men decided the type of crops to be cultivated.

Determinants of women farmers' participation in agricultural environmental management

Agricultural environmental management will greatly determine the sustainability of a farming and in managing a farming it is necessary to involve women farmers. Various obstacles are faced by women in their efforts to participate in AEM, to overcome this, it is necessary to know what determining factors influence women to participate in AEM. Ordinal regression is used in this study to find out determinants influencing women farmers to participate in AEM; Assumption for using ordinal regression is that between predictor variables there is no multicollinearity. The results of the multicollinearity test in this study, are as in the following table.

Results of the analysis as can be seen in the Table 4, there is no multicollinearity in all predictors. Where the tolerance value of all predictors is >0.10 and the VIF value is <10. Thus, all predictors can be included in the ordinal regression model.

Goodness of fit test

The purpose of this statistical test is to determine whether the observed data consistent with the fitted model. The null hypothesis states that the fit is good. If this hypothesis is not rejected (for example, if the p-value is large), then it can be concluded that the data and model predictions are similar and the model is a good fit. However, if $p<0.05$, then the model does not fit the data. The results of the analysis indicate that the model is good, as shown in the table below.

For the model suitability test, the results of the analysis carried out as can be seen in Table 5, produced a sig value > α (0.5), which is 0.566 and a statistical value for the

Table 2: Land size.

Land area (Acre)	Land area category	Number Resp.	Percentage
< 50	Narrow	67	81.71
50-200	Medium	15	18.29
≥ 200	Large	0	0.00
Total		82	100.00

Table 3: Women farmer participation category.

Participation score	Category	Number of respondent	Percentage
< 22.62	Low	12	14.63
22.62-32.62	Moderate	55	67.07
≥32.62	High	15	18.30
Total		82	100.00

Table 4: Result of multicollinearity test.

Predictor variables	Tolerance	VIF
Age	0.461	2.171
Education	0.786	1.272
Family size	0.962	1.040
Farming experience	0.474	2.109
Land size	0.827	1.209
Farmer group	0.937	1.067

Table 5: Goodness of fit tests.

	Chi-squares	df	Sig.
Pearson	150.441	154	0.566
Deviance	101.268	154	1.000

Table 6: Determinant of woman participation.

		Parameter estimates						
							95% Confidence interval	
		Estimate	Std. error	Wald	df	Sig.	Lower bound	Upper bound
Threshold	[Participate]	5.102	3.184	2.567	1	0.109	-1.140	11.343
Location	Education	0.786	0.449	3.066	1	0.080	-0.094	1.665
	Family size	1.229	0.456	7.258	1	0.007	0.335	2.123
	Farming experience	0.009	0.047	0.036	1	0.850	-0.084	0.101
	Land size	0.001	0.015	0.004	1	0.951	-0.029	0.031
	Age	0.042	0.058	0.527	1	0.468	-0.072	0.156
	[Farmer group-0]	-0.349	0.686	0.259	1	0.611	-1.694	0.996

Goodness of Fit Test of 150.441, which is less than χ^2 (0.1; 154), which is 183.959, so that H0 is not rejected, meaning that the model regression obtained is appropriate or between the observation results and the prediction results there is no difference.

After conducting an analysis of the ordinal regression, the results of the ordinal regression for the determinants of female farmer participation in environmental management were obtained as follows:

According to Table 6, education has a positive significant impact on participation of women's in agricultural environmental management. This shows that when women achieve higher levels of education, participation will also increase. Education generally provides individuals with better decision-making and problem-solving skills. Farmers education with higher levels tend to have superior skills in strategizing and supervising agricultural activities, this finding is also the same as (Sallawu *et al*., 2022; Zone *et al*., 2023) who found that education have a significant effect on women's participation in agriculture activities. fairly Educated female farmers have the opportunity to obtain and understand information about agricultural management and are motivated to participate in agricultural activities.

Family size has a positive significant impact on the participation of women farmers this result is consistent with (Meena, 2017; Sallawu *et al*., 2022; Zone *et al*., 2023). With the number of family members increasing, women are motivated to participate in managing agriculture which can provide income and improve the welfare of farming families, optimal resources and increased productivity.

Experience in farming and farm size also have a positive significant effect on participation of women's in agricultural environmental management, experience provides knowledge about good techniques in agriculture (Kingdom *et al*., 2019) such as soil health management, fertilizer application, use of crop residues as mulch and pest and plant disease control.

Land size has a significant positive impact on women's participation, land area increase is associated with an increase in participation of women's in agricultural management by 0.1%. Larger land requires more labor, this can cause significant challenges for women farmers to participate in managing farms to increase land productivity (Das, 2023; Kingdom *et al*., 2019; Lamichhane *et al*., 2022). Farmer groups are important in distributing agricultural information, agricultural inputs such as fertilizers, agricultural facilities are also easier to obtain by becoming members of farmer groups, so farmers need to be members of farmer groups. The results of the analysis show that not being a member of a farmer group has a negative significant effect on women's participation in environmental management, with a decrease in participation of 34.9%. The decrease in participation in AEM is caused by women who are not farmer groups members losing the opportunity to obtain various information related to agricultural management and the ease of obtaining agricultural inputs and facilities. Information related to sustainable agricultural environmental management is generally obtained by becoming members of a farmer group in rural areas, in addition, farmer groups are also a place where farmers can meet at certain times and can exchange agricultural information that can motivate farmers in managing farms towards a more advanced and sustainable direction.

CONCLUSION

The results of this study indicate that The farming pattern carried out by respondents is dry land farm, with an average land area of 24,61 acre or included in the "narrow" category. with the cultivated types of crops are vegetables, rice, corn, cassava,beans.nuts, papaya, banana, cashew and coconut. The vegetables, corn and beans planting pattern, is planted generally using a planting pattern intercropping, where two or more plants are planted at the same time without different row arrangements on the same land. Participation of Women Farmers has an average score of 27.71 or participation is included in the "moderate" category. Several factors, including education, age, household size, farming experience, land size and farmers group membership influence women's participation in farm management. So it can be suggest that efforts to increase women's participation in agricultural environmental management require increasing knowledge and skills,

providing policies that support women's involvement in farmer groups as a source of knowledge about various new innovations and support facilities and designing policies that empower women farmers to be able to actively participate in sustainable agricultural management.

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Conflict of interest

All authors declare that they have no conflict of interest.

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