International Journal of Sustainable Development and Planning
Vol. 17, No. 7, November, 2022, pp. 2033-2043
Journal homepage: http://iieta.org/journals/ijsdp

The Sustainability Model of Dryland Farming in Food-Insecure Regions: Structural Equation Modeling (SEM) Approach

Erlyna Wida Riptanti[1,2*], Masyhuri[3], Irham[3], Any Suryantini[3]

[1] Department of Agribusiness, Faculty of Agriculture, Universitas Sebelas Maret, Surakarta 57126, Indonesia
[2] The Center for Micro, Small and Medium Enterprises and Cooperative Studies, Universitas Sebelas Maret, Surakarta 57126, Indonesia
[3] Department of Agribusiness, Faculty of Agriculture, Universitas Gadjah Mada, Sleman 55281, Indonesia

Corresponding Author Email: erlynawida@staff.uns.ac.id

https://doi.org/10.18280/ijsdp.170704

Received: 20 January 2022
Accepted: 5 September 2022

Keywords:
environment, economic, farming system model, water and land conservation

ABSTRACT

Agricultural sustainability is a prerequisite for reducing poverty and food insecurity. The readiness of food is closely linked to food security and the sustainability of dryland farming. It shows a vital position in food-insecure zones. This article purposes at presenting the analyses of the sustainability model of dryland farming in food-insecure regions. The research was carried out in East Nusa Tenggara Province, which is a region with a relatively high food insecurity level in Indonesia. The samples of farmers include 240 respondents taken using the combination of purposive and snowball samplings. Survey, interviews, and observation methods were applied to gather the data, which include main and supporting data. Data were examined with Structural Equation Modeling. The research model was built based on inputs, processes, outputs, food security, both directly and indirectly, affecting the sustainability of dryland farming. The outcomes of the study have shown that the sustainability of dryland farming can be improved by using government inputs and environmental inputs, reducing family resource inputs, using appropriate farming system models, utilizing government policies, increasing output, and strengthening the food security of farmers' households. Farmers are rational in making decisions about the sustainability of their farming management which is challenged with limitations.

1. INTRODUCTION

One of the biggest threats to the agricultural system is climate change [1] which exacerbates food insecurity in poor areas. Climate change significantly affects the agricultural system, either directly or indirectly on food crops, cropping systems, livestock, pests and diseases, weeds, which threaten food security [2, 3]. Dryland farming and its productivity depend on micro-climate and its changes over time. Every change in rainfall impacts to the productivity and sustainability of the planting system, soil fertility and water availability. Based on the Pusat Data dan Sistem Informasi Pertanian [4] in 2012-2016, dryland was spread in every province in Indonesia. Overall, the dryland area, consisting of drylands and bare fields, has a higher proportion than rice fields, with an average area of 67.5% for the past 5 years. This is a huge potential to develop dryland farming. However, dryland farming has the potential to low productivity, limited economic growth, and marginalization if the practice is without support and assistance [5].

One of the priority provinces in the handling of food insecurity in Indonesia is East Nusa Tenggara (ENT). The population working in the agriculture sector is more than 50 percent, but the area of food insecurity is 37 percent of the total area. Another fact is the dryland area of 83.13%, compared to paddy fields [6]. This is a potential natural resource but is also an obstacle in the development of dryland farming. The government has implemented policies aimed at increasing the productivity of agricultural products and suitable farming system models, but many areas are still food insecure. At present, policies, activities and development goals for poverty alleviation cannot be achieved without significantly paying attention to dryland [7]. Repeated drought in ENT has contributed to the low productivity of food crops and other agricultural products. Therefore, agriculture needs to be managed effectively because it plays a key role to fullfil the supply of foodstuff and raw material.

Sustainability is the capability of a system to retain productivity despite various disruptions and vulnerabilities [8]. Sustainability is a dynamic concept i.e. sustainability in one area may not exist in another, and what is believed sustainable at one time may no longer be sustainable nowadays or in the future because circumstances or attitudes are different [9]. The concept of farming systems applied as an approach to sustainable farming systems, according to Widodo [10], must meet three criteria, namely animal and plant productivity, socio-economic viability, and maintenance of resources in the long run. External factors include the natural, cultural and institutional environments. The aim of this paper is to analyze the sustainability model of dryland farming in food-insecure regions. The model of dryland farming sustainability is very important to be explored since the population living in the areas is faced with limitations in land productivity, water availability, agricultural inputs, economic and food availability.

The sustainable farming system consists of several interrelated components, namely irrigation management, soil fertility management, cropping systems, integrated plant pest and disease control, risk management, and social capital management [11]. The research model is developed based on inputs, processes, and outputs in the farming system [11] and food security that directly and indirectly affect the sustainability of dryland farming. Variables of government input, environmental inputs, family resource inputs, farming models, management, policies and food security are the novelties of the model in this study. These variables have not been studied with the support of empirical data. The novelty also lies in the sustainability variable of dryland farming. These variables are reflected with environmental, economic and social/institutional dimensions, by previous researchers [12-14]. These dimensions are exogenous variables that affect the sustainability in Structural Equation Modeling (SEM) approach. On the other hand, the sustainability of dryland farming is measured by the environmental, economic and social dimensions that have been proposed by Searca et al. [15-19]. This is contrary to the sustainability model developed by Ashadi and Kalantari [12], Yasar et al. [13], Asyari and Dewi 14]. The contribution of the results of this research bridges the results of previous researchs, which are supported by empirical data and the gap in the concept of sustainability. This model can help farmers increase the output and sustainability of their farming system management.

2. LITERATURE REVIEW

Central issue of sustainable development is sustainable agriculture that includes the development of complex systems [20]. The multidimensional perspective recognizes the existence of an economic dimension that needs eligibility, a social dimension that needs acceptance, and an environmental dimension that needs carrying capacity [19, 21, 22]. Therefore, sustainability performance is defined to achieve the best environmental, social, and economic outcomes.

The sustainable farming system is made up of several interconnected components. As modified by Maji [11], the farming system is part of a larger system that covers a range of subsystems that include relatively fixed physical, farm family resources, and government variable input. In the operational system, these inputs are combined to produce outputs. The model of agriculture outlooks farms as factories and regards fields, plants, and animals as production units [23]. Sustainable agriculture is grounded on an all-inclusive paradigm or model of development, which considers production units as organisms that comprise of many multifaceted interrelated sub-organisms, all of which have dissimilar physical, biological, and social limits. People are regarded as parts of the organisms or systems, from which they stem their well-being [23].

Torres and Shah [24] use the household farming system as an approach to sustainable agriculture. The farming system is seen as a holistic system that is managed by farmers by operating best management practices to combine and respond to various physical-biological, socio-economic, and resource environmental factors available to them for maximizing benefits or minimizing farming risks. The development of farming systems is fundamental to achieve sustainable agriculture. Various models of farming systems that can be developed to ensure the achievement of a sustainable agricultural system model include a diversified farming, an organic farming, an agroforestry, and a mixed farming [25]. Government policy aims to increase the capacity of agricultural-based leading economies [26]. Sustainable food production is vital to achieve to ensure food security and sustainable agriculture.

Food security is a major component of sustainable agriculture, both conceptually and historically. Agriculture sustainability and food security are interconnected [27], as evidenced by attitudes toward ecological, markets, quality, social, aid programs, food sovereignty, technology, and health factors. Food security is supported by “triad concepts” [28], which includes food availability, food access, and food utilization.

Farmers’ perspectives of sustainability are used in both values and modeling methods where diverse dimensions of sustainability are combined and/or compared [29, 30]. Research on variables that affect the sustainability of dryland management is limited. Therefore, formulation of hypotheses and models developed is done the hypothesis proposition. However, some researchers, including [12, 14], have reviewed the areas of research using the SEM approach. The studies have reported that ecological/ environmental, economic and social/ institutional variables are endogenous and sustainability variables are exogenous. Moreover, the research resulted by Yasar et al. [13] has concluded that ecological, economic and social variables are endogenous variables that explain sustainability. Institution and technology are exogenous variables that affect sustainability.

3. METHOD

3.1 Research location

This research was carried out in ENT Province. The samples of research locations were faced with more severe food insecurity and high poverty in Indonesia [31]. The research locations include the areas in Timor, Flores, and Sumba islands. From each island, one regency with the highest food insecurity was used as a sample. From each regency, two sub-districts with food insecurity were used as research locations. Further, from each sub-district, two villages, either food insecure or food secure village, or both, which were relatively accessible by four-wheeled vehicles, from each selected sub-district (see Table 1 and Figure 1).

Table 1. Research location

Island	Regency	Sub-district	Village
Timor	South Timor Tengah	Batu Putih	Oehela, Tuakole
		Kota Soe	Cendana, Karangsiri
Flores	East Manggarai	Borong	Poco Rii, Kota Ndora
		Kota Komba	Gunung Baru, Rana Bata
Sumba	East Sumba	Ngaha Ori Angu	Tana Tuku, Pulu Panjang
		Kambata Mapambuhang	Waimbidi, Luku Wingir

The three regencies are mountainous or hilly areas with less fertile soil conditions because they contain more rocks. The areas have low rainfall (only around 4 months) and are potentially catastrophic. People depend on the agricultural sector for their livelihoods with a relatively high poverty rate. Access to transportation, capital and marketing are hampered due to limited infrastructure.

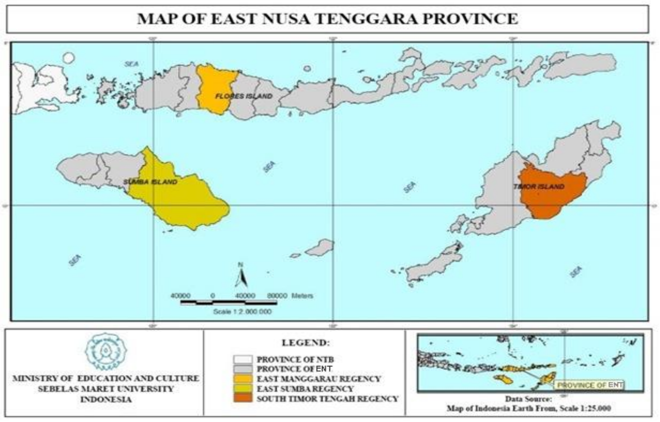

Figure 1. Map of research location

3.2 Data collection

The population in this study are farmers who practice dryland farming in food-insecure regions. Based on one of the assessments of the composite index for determining food-insecure areas is the illiteracy population index, the researcher assumes that the level of farmers' education, knowledge, and understanding of the object of study is relatively low. Non-probability sampling method was applied to take samples of farmers. The samples were chosen with purposive sampling technique by reasoning that 1) farmers have the cleverness to understand, respond to questions, and communicate effectively, and 2) farmers are available at home. Snowball sampling technique was also applied to take samples because 1) not every member of the farmer's household can communicate using Indonesian, and 2) the head of the household/wife is not at home because of staying on the farm. A mount of 240 farmers participated in this research, with 20 farmers from each village. In-depth information that supported this study was obtained from the head of Agricultural Services and Food Security Agencies of each district and province, the agricultural field extension officers, farmer group managers, and the village government officials.

Research data include primary data and secondary data. The primary data were dryland farming system, farmer household resilience, dryland farming sustainability, factors influencing dryland farming sustainability. The secondary data were gained from the Central Bureau of Statistics (BPS), the Department of Agriculture, the Food Security Agency, at the district and provincial levels which were the research locations. The data were gathered using survey, observation and interview methods. The interview was carried out by visiting respondents directly to obtain the needed information. The questionnaires were filled in by the researchers. The observation was done by directly monitoring the study objects and the data obtained in the form of field notes [32].

3.3 Research area

SEM approach of the research model is built from inputs, processes, outputs, food security, and sustainable management of dryland farming. The latent variables of government input, environmental input, family resource input, farming model, management, policies and food security are the novelty in this research model. The model developed of dryland farming management sustainability is reflected by the indicators of the environmental, economic and social dimensions. These variables have not been examined by previous researchers with the support of empirical data (Table 2). The type of relationship between indicator and their latent variables are reflective. Model testing was performed in two stages, including measurement model using validity and reliability tests and structural model using the test of model fit and quality indices. The testing was carried out on the questionnaires before data were taken.

Table 2. Latent variables and the indicators in the model

Exogenous Variable	Indicator
Government input (X1)	Credit policy ($X_{1.1}$)
	Subsidy policy ($X_{1.2}$)
	Price policy ($X_{1.3}$)
	Research institute support ($X_{1.4}$)
Environment input (X2)	Climate ($X_{2.1}$)
	Water availability ($X_{2.2}$)
	Access to farmland location ($X_{2.3}$)
	Frequency of pest and disease attacks ($X_{2.4}$)
	Topography ($X_{2.5}$)
	Land fertility ($X_{2.6}$)
Family resource input (X3)	Age of farmer ($X_{3.1}$)
	Farmer education ($X_{3.2}$)
	Land tenure ($X_{3.3}$)
	Availability of labor ($X_{3.4}$)
	Availability of farming capital ($X_{3.5}$)
	The purpose of farming ($X_{3.6}$)
	Availability of infrastructure for rice production ($X_{3.7}$)
Farming system model (X4)	Diversified farming system model ($X_{4.1}$)
	Organic farming system model ($X_{4.2}$)
	Agroforestry system model ($X_{4.3}$)
	Mixed farming system model ($X_{4.4}$)
Management (X5)	Capital management ($X_{5.1}$)
	Planting time management ($X_{5.2}$)
	Labor management ($X_{5.3}$)
	Cooperation management ($X_{5.4}$)
	Marketing management ($X_{5.5}$)
Place of origin (X6)	Dummy of Timor Island ($X_{6.1}$)
	Dummy of Flores Island ($X_{6.2}$)
	Dummy of Sumba Island ($X_{6.3}$)
Policy (X7)	Scale-up of business ($X_{7.1}$)
	Increase of livestock ownership ($X_{7.2}$)
Endogenous Variable Output (O)	Productivity (O_1)
	Farmer income (O_2)
Food security of household farmers (Z)	Food availability (Z1)
	Food sufficiency (Z_2)
	Food access (Z_3)
	Food quality (Z_4)
Sustainability of dryland farming management (Y)	Accuracy of the arrival of the rainy season every year (Y_1)
	Drought event (Y_2)
	Water conservation (Y_3)
	Land suitability (Y_4)
	Land conservation (Y_5)
	Use of fertilizer (Y_6)
	Utilization of agricultural waste (Y_7)
	Use of pesticide (Y_8)
	Planting frequency management (Y_9)
	Use of seeds (Y_{10})
	Shifting cultivation (Y_{11})
	Land tenure status (Y_{12})

Exogenous Variable	Indicator
	The mechanism for arable land sharing (Y_{13}) (Cultivating farmer: Owner)
	Feasibility of farming (Y_{14})
	Marketing access (Y_{15})
	The role of the institution providing capital (Y_{16})
	The role of marketing institution (Y_{17})
	The agricultural extension (Y_{18})
	Participation of family members in managing dryland (Y_{19})
	Dryland management pattern (Y_{20})
	Community empowerment (Y_{21})
	The habit of mutual assistance (Y_{22})
	The role of agricultural insurance (Y_{23})
	The role of farmer group (Y_{24})
	The occurrence of conflict (Y_{25})

3.4 Validity and reliability

If the correlation coefficient is greater than 0.30, the research instruments are said to be valid and suitable for use in research. The validity and reliability of the questionnaire were tested on 30 farmers in Kupang City. The results of validity test on the research instruments using Pearson correlation analysis are presented in *Appendix*. Reliability testing with the one-shot method was performed using Cronbach Alpha (α). A variable is said to be reliable if the value of α is ≥ 0.60. *Appendix* shows that the results of the validity and reliability tests of the questionnaire recorded that not all questions in the questionnaire were valid, which is X6 so that the variable was not further used in the study. Indicators having a pearson correlation coefficient greater than 0.30 were utilized as the research instruments [33]. The test resulted in α value of 0.703 and thus, the questionnaire was reliable.

The relationship between exogenous and endogenous variables or vice versa was determined by examining the structural model as follows:

$$O=\gamma_1X_1+\gamma_2X_2+\gamma_3X_3+\gamma_4X_4+\gamma_5X_5+\gamma_6X_7+\varepsilon_{61} \quad (1)$$

Hypothesis 1 (H1): Government input, environment input, family resource input, farming system model, management, policy are estimated to have an effect on output.

$$Y=\gamma_7X_1+\gamma_8X_2+\gamma_9X_3+\gamma_{10}X_4+\gamma_{11}X_5+\gamma_{12}X_7+\varepsilon_{64} \quad (2)$$

Hypothesis 2 (H2): Government input, environment input, family resource input, farming system model, management, policy are estimated to have an effect on sustainability of dryland farming management.

$$Z=\beta_1O+\varepsilon_{62} \quad (3)$$

Hypothesis 3 (H3): Output is estimated to have an effect on food security of farmers' households.

$$Y=\beta_2O+\varepsilon_{59} \quad (4)$$

Hypothesis 4 (H4): Output is estimated to have an effect on sustainability of dryland farming management.

$$Y=\beta_3Z+\varepsilon_{60} \quad (5)$$

Hypothesis 5 (H5): Food security is estimated to have an effect on sustainability of dryland farming management.

$$Y=\beta_4O+\beta_5Z+\varepsilon_{63} \quad (6)$$

Hypothesis 6 (H6): Output and food securityof farmers' houldholds is estimated to indirectly have an effect on sustainability of dryland farming management.

Data analysis was performed using SEM with WarpPLS 6.0 software.

Testing of hypotheses H1 and H2:

H_0: $\gamma i=0$

H_1: $\gamma i\neq 0$

Hypothesis testing was significant if p-value < 0.05.

Testing of hypotheses H3; H4; H5 and H6:

H_0: $\beta i=0$

H_1: $\beta i\neq 0$

Hypothesis testing was significant if p-value < 0.05.

4. RESULTS AND DISCUSSION

4.1 The goodness of fit model in WarpPLS

Data collected through questionnaires were then re-examined for the validity and reliability to minimize biases. Discriminant validity is seen from the comparison of the AVE (Average Variance Extracted) root value with the correlation coefficient. The questionnaire is said to be valid discriminant, if the AVE root is greater than the correlation coefficient with other variables [33]. The AVE root value of a latent variable from the output WarpPLS is greater than the correlation between latent variables, signifying that the latent variable used is said to have good discriminant validity.

Composite reliability (CR) is a measurement that has a dimensional structure obtained from an instrument with independent test component and other components. The questionnaire is said to have good composite reliability if the CR is $\geq$ 0.70. The results of the retest show that the discriminant is valid and the composite reliability is fulfilled. Therefore, the data can be used further.

The goodness of fit for the structural model was measured using the R-square endogenous variable, which was Q-Square predictive relevance. It was done with the formula:

$$Q^2=1-(1-R_1^2)\,(1-R_2^2)\,(1-R_3^2)$$

where, R_1^2, R_2^2, R_3^2 amounted to 0.38, 0.10 and 0.51, respectively, so the Q^2 value=0.7266. Q^2 value ≥ 0.7 is said to be feasible, meaning that the model is viable so that it has a relevant predictive value. This indicates that the diversity of data can be explained by the model. The remaining 27.34% is explained by other variables, which are not contained in the model and are considered an error. The researchers suspect that other variables are cultural conditions, motivation, farmers' intention to improve productivity, farmers' entrepreneurial spirit, technology, innovation.

The SEM approach is fit using the test criteria of fit and quality indices model. The test answers whether the research model is suitable for the data, meaning that it is important to compare the results of the study. The fit and quality indices model section displays several fit indicators, namely average path coefficient (APC), average R-squared (ARS) and average adjusted R-squared (AARS). P-values are given for the APC, ARS and AARS indicators calculated by resampling estimation and Bonferroni like correlation. This is necessary because they are both calculated as parameter averages. The p-value of all three is below 0.05 or it means that it is significant. This means that latent variables can improve the quality of the overall explanation and prediction. The Tenenhaus GoF (GoF) value of 0.342 is the middle category in measuring the strength of the model's explanation. The Sympson's paradox ratio (SPR) model should be independent of Simpson's paradox. Simpson's paradox instance is an indication of a problem of causality and the hypothetical pathway is nonsensical or the reverse. An SPR value of ≥ 0.800 means that it is ideal than Simpson's paradox instance. The R-squared contribution ratio (RSCR) is used to measure negatives R-squared contribution. The RSCR value of 0.971 means that the model is accepted and free of negative R-squared contributions. The statistical suppression ratio (SSR) used to measure a model must be free of suppression instances. An SSR value of 1 means that the model is accepted and free from suppression instances. The nonlinear bivariate causality direction ratio (NLBCDR) is used to explain how far the coefficient of the relationship between two non-linear variables supports the hypothesized direction of the influence model. NLBCDR value ≥ 0.733 means that the model is accepted. Based on the test of fit and quality indices model, all testing criteria are fit. This indicates that the analyzed model is very good and further interpretation in the hypothesis testing can be made [33].

4.2 Measurement of structural model

The structural model measures the effect of one variable on another. The direct relationship occurs between exogenous with endogenous variables. This direct effect also happens among endogenous variables (Table 3 and Figure 2).

The results of testing of H1 untill H5 are presented in Table 3 and Figure 2, which signify that the variables X2, X3, X4 and X7 directly influence the variable O, while the variables X2, X3 and O directly influence the variable Y with $\alpha \leq 5\%$. On the other side, variable O directly affects the variable Z and variable Z has no direct effect on Y. Figure 2 demonstrates that the greatest direct effects on variable O are given by the variable X7 with 0.444 and X2 with 0.284. This implies that the variable X7 contributes greatly to the output. Variables X1 and X5 do not affect variable O, while the greatest direct effect on the variable Y is caused by variable X2 that is equal to 0.614. This means that the X2 gives the biggest contribution in influencing Y.

Testing of hypothesis H6 measures the indirect effects, which are the sequences of the path, through one or more mediating variables. Indirect effects were analyzed using two and three segments of mediation variables. The result of the output WarpPLS, the exogenous variables that have a stronger influence on endogenous variables can be seen from the whole analysis model. Indirect and total effects can explain how the goals of the system can be achieved. Variable O is a mediating variable for the effect of X7 on Y. On the other hand, the direct effect of X7 on Y is not significant, so the output is a complete mediation variable. Government policies are getting better regarding the scale of farming and livestock ownership that will be followed by outputs of increased productivity and farmers' income. Three segments of mediation variables that there are no variables that are mediating.

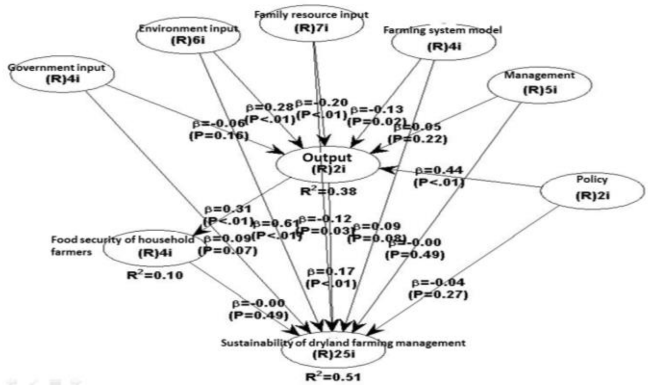

Figure 2. The results of the structural model testing
Source: Output WarpPLS

The total effect of the path is the sum of direct and indirect influences. The testing of the total effects was only conducted on the paths whose mediating variable effects are significant. The total strength of effect was calculated from the absolute contribution of X7 to Y:

$$=(\text{path coefficient})^2 \times 100\%$$
$$=(0.073)^2 \times 100\% = 0.533\%.$$

Table 3. The results of hypothesis testing

Direct Effects		**Endogenous Variables**			
		O		**Y**	
		Path Coefficient	**p-value**	**Path Coefficient**	**p-value**
Exogenous variables	Government input (X1)	0.063	0.16 ns	0.097	0.073*
	Environment input (X2)	0.284	<0.001***	0.614	<0.001***
	Family resource input (X3)	-0.196	<0.001***	-0.121	0.029**
	Farming system model (X4)	-0.130	0.02**	0.088	0.084*
	Management (X5)	0.049	0.22 ns	-0.001	0.494 ns
	Policy (X7)	0.444	<0.001***	-0.039	0.269 ns
Endogenous variables	Output (O)			0.166	0.004***
	Food security of household farmers (Z)			-0.002	0.489 ns
		Z			
		Path Coefficient		p-value	
	Output (O)	0.314		<0.001***	

Source: Output WarpPLS
Notes:
ns: *non significant*
***: Significant at the error rate (α) of ≤1% (highly significant)
**: Significant at the error rate (α) of ≤5% (significant)
*: Significant at the error rate (α) of ≤10% (weakly significant)

The strength of the influence of X7 on Y is 0.533%, meaning that government policy for increasing the scale of farming and livestock ownership is important. Based on the land tenure in the study area, agrarian reform policies to increase farmers' land need to be implemented properly to improve the welfare of peasant or small farmers.

4.3 Discussion

The latent variable of policy is reflected by the indicator of policy for increasing business scale and livestock ownership, which contribute to the increase in output. The outcomes of this research are in the line by the results of previous researchs that examine the subjects. The studies by Scherr [34] note that policies on an increase in production scale, development of labor-intensive agroindustry, development of physical and institutional infrastructures, technology, and capital put effects on the increase in production capacity, income and alleviation of farmer poverty. Meanwhile, studies on animal husbandry, signifying that greater livestock ownership is positively correlated to income and welfare. Livestock ownership can be increased by accessing credit, whose scheme is following the actual conditions of the farmers, in which the types of collateral are easily provided with the loan interest rates between 0 - 0.5 percent per month.

The policy to increase farmers' business scale is carried out by increasing capital from cultivation to post-harvest management, increasing the scale of production, improving technology, and business network. Livestock manure is significant in the nutrient cycle in dryland farming. Animal feed is resourced from pasture and agricultural waste [35]. However, the finding shows that livestock ownership is less effective in supporting sustainable agriculture. Therefore, the number of livestock needs to be increased. The policy to increase livestock ownership needs to be made and it can be implemented in several ways, which include the addition of direct grants, corporate social responsibility, and partnership programs.

Indicators that contribute greatly to the environment input latent variable are rainfall, topography, water availability and the frequency of pest and disease attacks (Figure 3). The result of the study by Ejaz et al. [36] is in line with the findings of this study that drought will reduce the production of dryland farming and agricultural irrigation. Rain in the study area only occurs during four months (December/January - March/April). Rainfall is a climate element with the highest diversity and fluctuation, so it is the most dominant climate element in Indonesia. Topography that is adjusted to the type of use and land suitability will increase crop productivity [37]. The results of the research by Riptanti et al. [38] exemplify that staple food crops that can be developed in the study area by adjusting the right cropping patterns when rainfall, temperature and humidity conditions are suitable for the commodity. Agricultural water demand is the largest part of total water demand which is determined by the potential of regional water resources. The application of the cropping pattern, planting time and planting period are determined by the factor of water availability. Increasing water availability is done by increasing water and land conservation. Extreme conditions during the rainy and dry seasons increase the frequency of pest and disease attacks. Empirical data show that most pest and disease attacks can damage plants by > 25% - 50% and break 1-25% parts of plants.

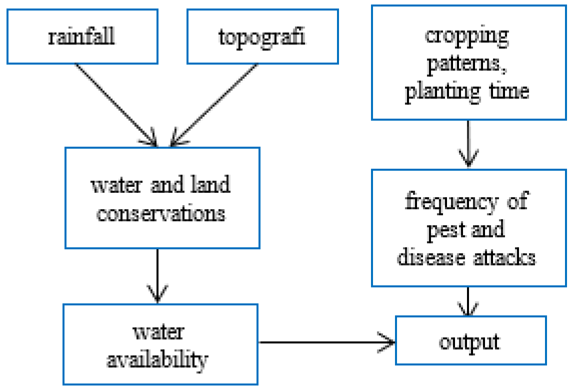

Figure 3. Environment input to effect on output

The direct effect of family resource input is an economic resource owned by farmers with limited availability. To obtain this input, farmers are required to make sacrifices [39, 40]. If one of the indicators, either farm capital availability, farmer education, availability of production facilities, or land availability, is increased, farmers will sacrifice the other resources of their family. The direct effect of the farming system model is that each increase in the farming system model contributes to the decrease in output. This result contradicts the results of studies by Lal [41] and Luedeling et al. [42] that mixed farming that includes agroforestry, land and water conservation and the use of livestock manure can increase the productivity of dryland. This direct effect is explained by the agroforestry and mixed farming system model, which are the most important indicators of the farming system model and give the greatest contribution in explaining the model. The interaction of trees and annual crops in soil management shows a positive response to the direct and indirect increase in productivity, as well as improvement of soil fertility, nutrient cycling, and soil conservation [43]. However, greater negative interactions occur in the study area due to the limited carrying capacity of the land to support the maximum number of populations and the limited supporting factors of plant growth on a particular land. These negative interactions support the results of the analysis. In the study area, agricultural land is maximally used without considering the carrying capacity of the land so that increased use of this model will reduce land productivity. The carrying capacity of the land is related to conflicts of interest in biomass use, nutrient and light competition, reduction in the area of cultivation, knowledge and skills of users and policy-makers.

The direct effect of government input and management on output variable is not significant. The results of this research differ from [44], that subsidy policies, pricing policies and institutional cooperation can increase profits for farmers. Policy of credit, subsidy and price, and research institution support, whose benefits have not been directly received by farmers in the research area. Research institutions have not provided significant support in increasing farmers' productivity or household income through the results of research or technology development in agriculture. Road access, transportation and communication are likely to be the main obstacles for research institutions to diffuse technological innovations in agriculture. On the other hand, farmers manage their farming based on resources and knowledge endowment [45]. As a result, farming management is monotonous, and there is no innovation, which has no effect on output.

Testing on the H1 hypothesis depicts that environment and policy input variables have a positive, direct and significant effect on output, while the variable of family resources and farming system models have a negative, direct and significant effect on output (Figure 4). The government and management input variables have no effect on the output. Based on these conditions, government policies in the form of credit, subsidy, and price policies have not been effective in increasing agricultural production. The effectiveness of these policies can be increased by improving facilities and infrastructure as well as institutions that support the implementation of these policies in the research area, such as the establishment of credit institutions that facilitate farmers in the sub-districts and villages, providing subsidies they require and distributing the subsidies timely. Farming management has no effect on output because farming is run based on ancestors' past experience. The current situation tends to be monotonous because there is no change in innovation and creativity in its management. Farming requires managerial functions to be performed to achieve high productivity and profitability.

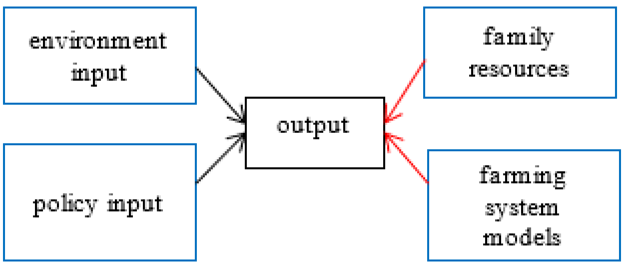

Figure 4. Testing on the H1 hypothesis

The direct effect of the environment input is that each increase in environment input affects the increase in sustainability of dryland farming management. The results of this study are in line with the results of previous researches by [41] that complex interactions take place in agriculture where soil ecosystems play an important role in sustainability. Abundant rainfall occurs during the rainy season but rainwater has not been utilized well in the dry season. Rainwater will partially become a surface runoff, and therefore, it cannot be benefitted by plants effectively. The impact of high surface runoff will cause a loss of soil humus, resulting in a decrease in soil fertility [46]. Therefore, farmers must apply the principles of water conservation to ensure the efficient use of rainwater in the dry season. One form of active community participation in water conservation is the formation of water reservoirs (*embung*). By building many *embung*, the crop index can be increased and the risk of failure to cultivate staple crops can be reduced [38]. Also, other efforts related to environmental inputs are made by improving agricultural techniques such as terracing and planting grass on the edge of the terrace.

The direct effect of the family resource input is that each increase in family resource input contributes to the decrease in sustainability of dryland farming management. One of the problems hampering sustainable agriculture is the low rate of farmer adoption in technology innovation so that productivity is not optimal. The level of adoption in technological innovation requires the support of adequate farming equipment, the availability of capital in implementing sustainable farming activities and the education of farmers in supporting sustainable farming activities [44]. In the farmers' household's real life, the family resource input is faced with limitations, and thus, if farmers increase one input, they will need to reduce the other inputs of family resources, and this will reduce the productivity, as well as decrease the farming efficiency. This, in the long run, the fulfillment of food needs and environmental quality will decrease, resulting in a decrease in the sustainability of dryland farming management.

Variables of government input and farming system model have positive and significant but weak effect on sustainability of dryland farming management. Sustainable agriculture cannot be separated from the intervention of stakeholders and institutional cooperation. This institutional collaboration includes institutions for policy making, extension, research and development. As state institutions, the Agricultural Research and Development Agency and the Institute for Research and Community Service in Higher Education play important roles as innovators and technology inventors in sustainable cultivation.

Farming models, namely agroforestry and mixed farming, have long been practiced by dryland farmers in Indonesia. Farmers in the study area practiced the same models. When these two interactions between woody and seasonal plants are combined with livestock, has both positive and negative interaction values [47]. Positive interaction indicates that the seasonal plants can grow and produce well, whereas negative interaction signifies that the growth and production of annual plants will decline. One of the variables that affect the low productivity is the negative interaction. In a different light, agroforestry and mixed farming systems contribute to soil and water conservation. Plant diversity has a positive relationship with one another in the sustainability of dry land farming.

The direct effect of management is not significant to sustainability of dryland farming management. The results of this study contradict the opinion of Johns and Sthapit [48] that improved management has an effect on biodiversity conservation which in turn can increase farmers' income in a sustainable manner. The results of this study are also not in line with Pollock et al. [49] opinion that management can improve sustainability in terms of natural resources, social capital and human resource capacity. The effect of management on the results of this study is not significant because the average farmer manages capital, planting time, labor, mutual cooperation and marketing based on resources and knowledge endowment in limited conditions.

The direct effect of policy is not significant to sustainability of dryland farming management. The policy to increase business scale and livestock ownership has no significant effect on the sustainability of sustainability of dryland farming management. Indicators of constructing variables for the sustainability of dryland management according to Lefroy et al. [50] and Van Der Werf and Petit, [51], which are grouped into environmental quality, stable plant and animal production and social acceptability, the variation in policy cannot be predicted. This is because the policy variable is not directly related to the variable of Sustainability of Dryland Farming Management but requires a mediation variable so that the relationship is very meaningful.

Testing on hypothesis H2 depicts that the variables of government input, environment input, family resource input, and farming system model give a positive, direct, and significant effect to the sustainability of dryland farming management, while management and policy show the opposite trend. Farmer capacity building has not been able to implement the policies since they are not motivated to apply farming for commercial purpose. Therefore, they require stimulus to encourage them to apply Good Agricultural Practices (GAPs).

The direct effect of output variable is that an increase in output contributes to the increase in food security of farmers' households. Hypothesis testing shows that H3 is accepted. This is the same as the results of the study by Bocchiola et al. [52] that there is a positive correlation between productivity and food security. The availability of food of farmers' households is increased by multiplying productivity and agricultural production. Food availability is significantly related to food security and local food systems [53]. Improvement of farming systems can increase production both at the farm household level and production in the region and finally will be able to increase food security.

The direct effect of output is that each increase in output improves the sustainability of dryland farming management. Hypothesis testing shows that H4 is accepted. Sustainability is the ability of a system to manage productivity despite various disturbances and vulnerabilities. According to Johns and Sthapit [48], various factors affecting the productivity of dryland farming are also derived from traditional social culture and biodiversity conservation. The relationship between these factors influences each other which is linked by elements of improved management, knowledge, value, food quality, purchasing power in a system.

Interestingly, the direct effect of food security of farmers' households is not significant to sustainability of dryland farming management. Hypothesis testing shows that H5 is rejected. This finding differs from the results of research by Grando et al. and Berry et al. [27, 54]. Berry et al. [54] have reported that food security is a part of sustainability and sustainability is a part of food security. Sustainability is the resilience of the system and process. According to Grando et al. [27], there is a correlation between agricultural sustainability and food security, as seen in the attitudes towards ecological factors, markets, quality, social factors, solidarity, sovereignty, technology and health. On the other hand, Ghosh et al. and Richardson [55, 56] have recounted opposite results of studies. Ghosh et al. [55] have stated that conservation in agricultural cultivation is one indicator in the sustainability of dryland farming management that will increase the food security of farmers' households. Richardson [56] has also confirmed that ecosystems support each dimension of food security. The results of previous studies were merely based on the concepts/development of researchers' models of thinking, instead of empirical data. The outcomes of the present study indicate that the food security of farmers' households is mostly secure and dryland farming multidimensional management is less sustainable.

Output and household food security are not mediating variables that bridge exogenous variable and dryland farming sustainability. Testing on hypothesis H6 proves that H6 is rejected. Production is a process to transform production factor into a product. Exogenous variables that cover social/government input, environment input, family resource input, farming system model, management, and policy are responded, combined, and processed by famer households to produce outputs. Output variable depends on the direct influence of exogenous variables; and therefore, it does not follow the exogenous variables that affect the sustainability of dryland farming.

Seen from R^2, the exogenous variables of government input, environment input, family resource input, farming system model, management and policy are more determining than output and the food security of farmers' households in explaining the variances of the sustainability of dryland farming management. This is so because in the measurement of the sustainability of dryland farming management, some indicators from environmental, economic, and social dimensions can explain data variances, compared to indicators in output variable. Farmers' households continue their farming activities in spite of harvest failure or decrease in production. Famers need to change their mindset, motivated that dryland farming can be well-managed to increase productivity.

5. CONCLUSIONS

The main objective of the sustainability of dryland farming in food-insecure zones is to increase the productivity of dryland farming sustainably in strengthening food security. The model of dryland farming management sustainability is directly influenced by the variables of environmental input, family resource input, farming model system, government input and output, and indirectly affected by the variable of policy. Increased rainfall in the study area will have an impact on the adequacy of water availability to meet the needs of plant life. This will increase crop productivity and lessen the risk of crop failure due to drought. Improvement of conservation agriculture through improved management will increase farmers' productivity and income.

Output has a direct effect on food security. On the other hand, food security does not have a significant effect on the sustainability of dryland management. The findings are different from the outcomes of previous studies that food security is either influencing or correlating with the sustainability of farming. Based on the results of this study, farmers manage variables that put significant effects on the sustainability of dryland farming management.

The managerial implications of this study are farmers, who are also owners, managers and workers, manage variables that have both direct and indirect significant effects on output and sustainability of dryland farming management. Farmers can combine these variables by taking into account the degree of the influence of each variable. They must change their previous mindset and start believing that dryland farming can be better managed. Farmers must be instilled with an entrepreneurial spirit in order to raise awareness of their needs, and increase productivity and income. It is envisaged that by nurturing this entrepreneurial spirit, farmers will broaden their horizons, creativity, innovation, and willingness to learn in adopting Good Agricultural Practices (GAP). This will make it easier for farmers to incorporate the aforementioned variables into the sustainable management of their dry land farming.

This research is limited to the investigation in food-insecure areas with inadequate facilities and infrastructure, natural resources, and human resources. A more comprehensive study is required for applying the variables used in the model to the research areas with either uniform condition or different condition to determine the consistency of the research model developed.

REFERENCES

[1] Singh, R., Singh, G.S. (2017). Traditional agriculture: A climate-smart approach for sustainable food production.

Energy, Ecology and Environment, 2(5): 296-316. https://doi.org/10.1007/s40974-017-0074-7
[2] Ayinde, O.E., Muchie, M., Olatunji, G.B. (2011). Effect of climate change on agricultural productivity in Nigeria: A co-integration model approach. Journal of Human Ecology, 35(3): 189-194. https://doi.org/10.1080/09709274.2011.11906406
[3] Etwire, P.M. (2020). The impact of climate change on farming system selection in Ghana. Agricultural Systems, 179: 1-17. https://doi.org/10.1016/j.agsy.2019.102773
[4] Pusat Data dan Sistem Informasi Pertanian. (2017). Statistik lahan pertanian tahun 2013-2017. Kementrian Pertanian. http://epublikasi.setjen.pertanian.go.id/arsip-perstatistikan/167-statistik/statistik-lahan.
[5] Chizari, M., Ommani, A.R. (2009). The analysis of dryland sustainability. Journal of Sustainable Agriculture, 33(8): 848-861. https://doi.org/10.1080/10440040903303553
[6] Riptanti, E.W., Masyhuri, M., Irham, I., Suryantini, A. (2020). The ability of dryland farmer households in achieving food security in food-insecure area of East Nusa Tenggara, Indonesia. AIMS Agric Food., 5(1): 30-45. https://doi.org/10.3934/agrfood.2020.1.30
[7] Richard, T., Naomi, S., Thomas, S. (2014). Drylands Sustaining Livelihoods and Conserving Ecosystem Services. Institute for Water, Environment and Health (UNU-INWEH). United Nations University.
[8] Conway, G.R. (1987). The properties of agroecosystems. Agricultural Systems, 24(2): 95-117. https://doi.org/10.1016/0308-521X(87)90056-4
[9] Barry, S., John, S. (1993). Sustainable Agriculture: Interpretations, analyses and prospects. Canadian Journal of Regional Science/Revue Canadienne des Sciences Régionales, 16(3): 499-524.
[10] Widodo, S. (1998). Farming system approach for sustainable agriculture. Agro Ekonomi (Indonesia), 5(1): 1-6.
[11] Maji, C. (1991). Farming system approach to research. Indian J Agric Econ., 46(3): 403-411.
[12] Ashadi, A., Kalantari, K. (2013). Structural analysis of factors affecting agricultural sustainability in Qazvin Province, Iran. Journal of Agricultural Science and Technology, 15(1): 11-22. http://dorl.net/dor/20.1001.1.16807073.2013.15.1.14.1
[13] Yasar, M., Siwar, C., Firdaus, R.B.R. (2015). Assessing paddy farming sustainability in the Northern Terengganu Integrated Agricultural Development Area (IADA KETARA): A structural equation modelling approach. Pacific Science Review B: Humanities and Social Sciences, 1(2): 71-75. https://doi.org/10.1016/j.psrb.2016.05.001
[14] Asyari, M.A.H., Dewi, R.K. (2018). Analysis of factors influencing sustainability of social forestry (Case Study at bual forest farmer community. J Manaj Agribisnis., 6(2): 42-47. https://doi.org/10.24843/JMA.2018.v06.i02.p06
[15] Searca. (1995). Sustainable agriculture indicators. SEAMEO Regional Center for Graduate Study and Research in Agriculture (SEARCA). College, Laguna 4031, Philippines.
[16] Sydorovych, O., Wossink, A. (2008). The meaning of agricultural sustainability: Evidence from a conjoint choice survey. Agricultural Systems, 98(1): 10-20. https://doi.org/10.1016/j.agsy.2008.03.001
[17] Chizari, M., Ommani, A.R. (2009). The analysis of dryland sustainability. Journal of Sustainable Agriculture, 33(8): 848-861. https://doi.org/10.1080/10440040903303553
[18] Haileslassie, A., Craufurd, P., Thiagarajah, R. (2016). Empirical evaluation of sustainability of divergent farms in the dryland farming systems of India. Ecological Indicators, 60: 710-723. https://doi.org/10.1016/j.ecolind.2015.08.014
[19] Riptanti, E.W., Masyhuri, M., Irham, I., Suryantini, A. (2021). The improvement of dryland farming sustainable management in food-insecure areas in East Nusa Tenggara, Indonesia. Bulg J Agric Sci., 27(5): 829-837.
[20] Wu, W., Shibasaki, R., Yang, P. (2010). Modeling changes in paddy rice sown areas in Asia. Sustainability Science, 5: 29-38. https://doi.org/10.1007/s11625-009-0094-0
[21] Srivastava, P., Singh, R., Tripathi, S., Raghubanshi, A.S. (2016). An urgent need for sustainable thinking in agriculture - An Indian scenario. Ecological indicators, 67: 611-622. https://doi.org/10.1016/j.ecolind.2016.03.015
[22] Irianto, H., Mujiyo, M., Qonita, A., Sulistyo, A., Riptanti, E.W. (2020). The development of jarak towo cassava as a high economical raw material in sustainability-based food processing industry. AIMS Agriculture and Food, 6(1): 125-141. https://doi.org/10.3934/agrfood.2021008
[23] Ikerd, J.E. (1993). The need for a system approach to sustainable agriculture. Agriculture, Ecosystems & Environment, 46(1–4): 147-160. https://doi.org/10.1016/0167-8809(93)90020-P
[24] Torres, A.B., Shah, W. (1995). Household farming system for sustainable agriculture in Bangladesh. Farm Management Notes for Asia and The Far East, 20: 31-45.
[25] Rotz, C.A. (2004). The integrated farm system model: A tool for developing more economically and environmentally sustainable farming systems for the Northeast. The American Society of Agricultural and Biological Engineers, St. Joseph, Michigan. https://doi.org/ 10.13031/2013.16116
[26] Gómez, E.G., Sánchez, J.A.A., Mesa, J.C.P. (2013). Sustainability dimensions related to agricultural-based development: The experience of 50 years of intensive farming in Almería (Spain). International Journal of Agricultural Sustainability, 11(2): 125-143. https://doi.org/10.1080/14735903.2012.704306
[27] Grando, S., Brunori, G., Colombo, L. (2015). Quality, technology, sovereignty. Discourses on food security in Italy. Connecting Local and Global Food for Sustainable Solutions in Public Food Procurement, 14: 410. https://scholar.google.co.id/scholar?hl=en&as_sdt=0%2C5&q=Quality%2C+technology%2C+sovereignty.+discourses+on+food+security+in+Italy.&btnG=.
[28] Chung, K., Haddad, L., Ramakrishma, J., Riely, F. (1997). Identifying the food insecure: The application of mixed- method approaches in India. International Food Policy Research Institute. Washington, D.C.
[29] Williams, D.L. (2000). Students' knowledge of and expected impact of sustainable agriculture. Journal of Agricultural Education, 41(2): 19-24.
[30] Weaver, P.M., Rotmans, J. (2006). Integrated sustainability assessment: What is it, why do it and how? International Journal of Innovation and Sustainable Development, 1(4): 284-303.

https://doi.org/10.1504/IJISD.2006.013732
[31] Dewan Ketahanan Pangan. (2015). Food Security and Vulnerability Atlas 2015. Dewan Ketahanan Pangan. Kementrian Pertanian dan World Food Programme (WFP). Jakarta. https://www.wfp.org/publications/indonesia-food-security-and-vulnerability-atlas-2015.
[32] Hair, J.F., Ringle, C.M., Sarstedt, M. (2011). PLS-SEM: Indeed a silver bullet. Journal of Marketing Theory and Practice, 19(2): 139-152. http://dx.doi.org/10.2753/MTP1069-6679190202
[33] Blanthorne, C., Allison Jones-Farmer, L., Dreike Almer, E. (2006). Why you should consider SEM: A guide to getting started. Advances in Accounting Behavioral Research. Emerald Group Publishing Limited, Bingley, 9: 179-207. https://doi.org/10.1016/S1475-1488(06)09007-7
[34] Scherr, S.J. (2000). A downward spiral? Research evidence on the relationship between poverty and natural resource degradation. Food Policy, 25(4): 479-498. https://doi.org/10.1016/S0306-9192(00)00022-1
[35] Powell, J.M., Pearson, R.A., Hiernaux, P.H. (2004). Crop–livestock interactions in the West African drylands. Agronomy journal, 96(2): 469-483. https://doi.org/10.2134/agronj2004.4690
[36] Ejaz, Qureshi, M., Hanjra, M.A., Ward, J. (2013). Impact of water scarcity in Australia on global food security in an era of climate change. Food Policy, 38(1): 136-145. https://doi.org/10.1016/j.foodpol.2012.11.003
[37] Mujiyo, Suprapto, I.F., Wijayanto, H., Herawati, A., Irianto, H., Qonita, A., Riptanti, E.W. (2021). Land suitability assessment for cassava var. Jarak towo, using determinant factors as the strategy fundament in hilly area Jatiyoso-Indonesia. International Journal of Sustainable Development and Planning, 16(6): 1131-1140. https://doi.org/10.18280/ijsdp.160614
[38] Riptanti, E.W., Masyhuri, M., Irham, I., Suryantini, A., Mujiyo, M. (2018). The development of leading food commodities based on local wisdom in food-insecure area in East Nusa Tenggara Province, Indonesia. Applied Ecology and Environmental Research, 16(6): 7867-7882. https://doi.org/10.15666/aeer/1606_78677882
[39] Pannell, D.J., Llewellyn, R.S., Corbeels, M. (2014). The farm-level economics of conservation agriculture for resource-poor farmers. Agriculture, Ecosystems & Environment. 187: 52-64. https://doi.org/10.1016/j.agee.2013.10.014
[40] Brodt, S., Klonsky, K., Tourte, L. (2006). Farmer goals and management styles: Implications for advancing biologically based agriculture. Agricultural systems, 89(1): 90-105. https://doi.org/10.1016/j.agsy.2005.08.005
[41] Lal, R. (2013). Food security in a changing climate. Ecohydrol Hydrobiol, 13(1): 8-21. https://doi.org/10.1016/j.ecohyd.2013.03.006
[42] Luedeling, E., Kindt, R., Huth, N.I., Koenig, K. (2014). Agroforestry systems in a changing climate-challenges in projecting future performance. Current Opinion in Environmental Sustainability, 6(1): 1-7. https://doi.org/10.1016/j.cosust.2013.07.013
[43] Kassam, A., Friedrich, T., Derpsch, R. (2012). Conservation agriculture in the dry Mediterranean climate. Field Crops Research, 132: 7-17. https://doi.org/10.1016/j.fcr.2012.02.023
[44] Virianita, R., Soedewo, T., Amanah, S., Fatchiya, A. (2019). Farmers' perception to government support in implementing sustainable agriculture system. Jurnal Ilmu Pertanian Indonesia, 24(2): 168-177. https://doi.org/10.18343/jipi.24.2.168
[45] Adimassu, Z., Kessler, A., Hengsdijk, H. (2012). Exploring determinants of farmers' investments in land management in the Central Rift Valley of Ethiopia. Applied Geography, 35(1-2): 191-198. https://doi.org/10.1016/j.apgeog.2012.07.004
[46] Turtola, E., Alakukku, L., Uusitalo, R., Kaseva, A. (2007). Surface runoff, subsurface drainflow and soil erosion as affected by tillage in a clayey Finnish soil. Agricultural and Food Science, 16(4): 332-351. https://doi.org/10.2137/145960607784125429
[47] Hare, M.L., Xu, X.W., Wang, Y.D., Yuan, Y., Gedda, A.E. (2021). Do woody tree thinning and season have effect on grass species' composition and biomass in a semi-arid savanna? The case of a semi-arid savanna, southern Ethiopia. Front. Environ. Sci., 9: 692239. http://dx.doi.org/10.3389/fenvs.2021.692239
[48] Johns, T., Sthapit, B.R. (2004). Biocultural diversity in the sustainability of developing-country food systems. Food Nutr Bull. 25(2): 143-155. https://doi.org/10.1177/156482650402500207
[49] Pollock, C., Pretty, J., Crute, I., Leaver, C., Dalton, H. (2008). Introduction sustainable agriculture. Philos Trans R Soc B., 363: 445-446. https://doi.org/10.1098/rstb.2007.2193
[50] Lefroy, R.D.B., Bechstedt, H.D., Rais, M. (2000). Indicators for sustainable land management based on farmer surveys in Vietnam, Indonesia, and Thailand. Agriculture, ecosystems & environment, 81(2): 137-146. https://doi.org/10.1016/S0167-8809(00)00187-0
[51] Van Der Werf, H.M.G., Petit, J. (2002). Evaluation of the environmental impact of agriculture at the farm level: A comparison and analysis of 12 indicator-based methods. Agriculture, Ecosystems & Environment, 93(1-3): 131-145. https://doi.org/10.1016/S0167-8809(01)00354-1
[52] Bocchiola, D., Brunetti, L., Soncini, A., Polinelli, F., Gianinetto, M. (2019). Impact of climate change on agricultural productivity and food security in the Himalayas: A case study in Nepal. Agricultural systems, 171: 113-125. https://doi.org/10.1016/j.agsy.2019.01.008
[53] Kirwan, J., Maye, D. (2013). Food security framings within the UK and the integration of local food systems. Journal of Rural Studies, 29: 91-100. https://doi.org/10.1016/j.jrurstud.2012.03.002
[54] Berry, E.M., Dernini, S., Burlingame, B., Meybeck, A., Conforti, P. (2015). Food security and sustainability: Can one exist without the other? Public Health Nutrition, 18(13): 2293-2302. https://doi.org/10.1017/S136898001500021X
[55] Ghosh, P.K., Das, A., Saha, R. (2010). Conservation agriculture towards achieving food security in North East India. Current Science, 99(7): 915-921.
[56] Richardson, R.B. (2010). Ecosystem services and food security: Economic perspectives on environmental sustainability. Sustainability, 2(11): 3520-3548. https://doi.org/10.3390/su2113520

APPENDIX

The results of validity test on the research instruments

Variable	Indicator	r-count	Sig
X1	Credit policy ($X_{1.1}$)	0.379**	0.039
	Subsidy policy ($X_{1.2}$)	0.524***	0.003
	Price policy ($X_{1.3}$)	0.371**	0.044
	Research institute support ($X_{1.4}$)	0.406**	0.026
X2	Climate ($X_{2.1}$)	0.405**	0.026
	Water availability ($X_{2.2}$)	0.478***	0.007
	Access to farmland location ($X_{2.3}$)	0.529***	0.003
	Pest and disease attacks frequency ($X_{2.4}$)	0.553***	0.002
	Topography ($X_{2.5}$)	0.404**	0.027
	Land fertility ($X_{2.6}$)	0.493***	0.006
X3	Farmer age ($X_{3.1}$)	0.405**	0.027
	Farmer education ($X_{3.2}$)	0.449**	0.013
	Land tenure ($X_{3.3}$)	0.721***	0.000
	Labor availability ($X_{3.4}$)	0.368**	0.045
	Farming capital availability ($X_{3.5}$)	0.420**	0.021
	Farming purpose ($X_{3.6}$)	0.492***	0.006
	Infrastructure for rice production availability ($X_{3.7}$)	0.435**	0.016
X4	Diversified farming system model ($X_{4.1}$)	0.650***	0.000
	Organic farming system model ($X_{4.2}$)	0.632***	0.000
	Agroforestry system model ($X_{4.3}$)	0.611***	0.000
	Mixed farming system model ($X_{4.4}$)	0.693***	0.000
X5	Capital management ($X_{5.1}$)	0.588***	0.001
	Planting time management ($X_{5.2}$)	-0.689***	0.000
	Labor management ($X_{5.3}$)	-0.724***	0.000
	Cooperation management ($X_{5.4}$)	0.747***	0.000
	Marketing management ($X_{5.5}$)	0.530***	0.003
X6	Timor Island dummy ($X_{6.1}$)	-	-
	Flores Island dummy ($X_{6.2}$)	-	-
	Sumba Island dummy ($X_{6.3}$)	-	-
X7	Business scale-up ($X_{7.1}$)	0.426**	0.019
	Livestock ownership increasing ($X_{7.2}$)	0.459**	0.011
O	Productivity (O_1)	0.487***	0.006
	Farmer income (O_2)	0.600***	0.000
Z	Food availability (Z1)	0.810***	0.000
	Food sufficiency (Z_2)	0.754***	0.000
	Food access (Z_3)	0.694***	0.000
	Food quality (Z_4)	0.558***	0.001
Y	Accuracy of the arrival of the rainy season every year (Y_1)	0.582***	0.001
	Drought event (Y_2)	0.643***	0.000
	Water conservation (Y_3)	0.619***	0.000
	Land suitability (Y_4)	0.495***	0.005
	Land conservation (Y_5)	-0.458**	0.011
	Fertilizer use (Y_6)	-0.417**	0.022
	Agricultural waste utilization (Y_7)	-0.537***	0.002
	Pesticide use (Y_8)	-0.503***	0.005
	Planting frequency management (Y_9)	-0.469***	0.009
	Seeds use (Y_{10})	-0.393**	0.032
	Shifting cultivation (Y_{11})	0.465**	0.010
	Land tenure status (Y_{12})	0.498***	0.005
	Indicator	r-count	Sig
	The mechanism for arable land sharing (Y_{13}) (Cultivating farmer: Owner)	-0.477***	0.008
	Farming feasibility (Y_{14})	0.499***	0.005
	Marketing access (Y_{15})	-0.419**	0.021
	the institution providing capital role (Y_{16})	0.437**	0.016
	Marketing institution role (Y_{17})	0.411**	0.024
	The agricultural extension (Y_{18})	-0.472***	0.008
	Family members in managing dryland participation (Y_{19})	0.457**	0.011
	Dryland management pattern (Y_{20})	-0.365**	0.048
	Community empowerment (Y_{21})	0.432**	0.017
	Mutual assistance habit (Y_{22})	0.473***	0.008
	Agricultural insurance role (Y_{23})	-0.364**	0.048
	Farmer group role (Y_{24})	0.497***	0.005
	Conflict occurrence (Y_{25})	-0.447**	0.013

Data source: Output WarpPLS