# Empowerment of women farmers on sustainable food Security with dynamics system modelling (in Nagari Koto Tuo, Harau Sub-district, Limapuluh Kota Regency, West Sumatera)

IOP Conf. Series: Earth and Environmental Science **299** (2019) 012022 doi:10.1088/1755-1315/299/1/012022

# Empowerment of women farmers on sustainable food Security with dynamics system modelling (in Nagari Koto Tuo, Harau Sub-district, Limapuluh Kota Regency, West Sumatera)

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**Abstract**. Based on Observation in Nagari Koto Tuo showed that empowerment of women farmer group in food security has not been optimal yet. The indicators are: 1) the education of respondents is dominated by the elementary school (42.17%), thus greatly affect to food pattern and serving meal menu; 2) land productivity less than 0.5 ha is 71% and depends on rainwater (68%), 3) family expenditure is allocated mostly for food with calorie consumption less than 2100 kilocalories (63.66 %) and, only 36.7 % is a requirement of nutritional adequacy and mostly nutritional status are not ideal. The descriptions are indicated that the role of Nagari institution with the support of local wisdom is not optimal. Consequently, the management of food security has not been sustainable. The purpose of this study is the creation of a dynamic system model of empowerment of women farmers through several interventions. The research method is surveyed with observation and interview. The system dynamics (2018-2028) model is simulated by increasing the synergy intervention of women empowerment function and Nagari institutional for Nagari women's role (Bundo Kanduang). The intervention can be improved household welfare and can be reduced the poverty rate. The Implementation of the model is actualized by the empowerment of women farmers program according to carrying capacity environmental and local wisdom.

## 1. Introduction

One of the efforts to overcome the problem of food insecurity and rural poverty is through food independent village programs. Food independent village is a village that has food availability, accessibility, and utilization so that can lead healthy and productive lives from day to day, through the development of a food security system that includes the availability subsystem, distribution subsystem, and consumption subsystem by utilizing local resources in sustainable management.

Several approaches are needed in the development of food independent villages, including community empowerment, especially empowering women farmers. Community empowerment is a movement carried out to improve the ability of the community to be able to participate in realizing a food independent village. Community empowerment is a series of processes as an effort to improve the ability of the community in optimizing the potential of their resources to make better changes to achieve prosperity. This process is carried out by facilitating the community to be able to analyze their needs based on their life situation and problems.

The concept of empowering women is basically a new paradigm of development that is more accentuating sustainable "people-centered, participatory employing" traits. Although the meaning is different, still has the same goal, namely to build power, by encouraging, motivating and awakening

(awareness) of its potential, as well as the development of a better direction.

This concept was developed from the efforts of many experts and practitioners to find what efforts Friedmann cited [1], called "alternative development" which requires "inclusive democracy, appraising economic growth, gender equality and intergenerational equality " This means that women no longer only act as housewives who carry out reproductive functions, take care of children and husbands or other domestic jobs, but have actively participated in various fields of life, both social, economic and political. This is possible because of the existence of gender equality, intergenerational equality, and enhancing democratic life along with the times.

Women have long been known to have an important role as one of the cornerstones of producing food. They are involved in all stages of activities, ranging from tillage to marketing of results, especially in planting, weeding, harvesting, post-harvest, and marketing activities. The progress of agricultural technology that creates various agricultural facilities and infrastructures such as tractors, rice threshing machines, and others, indeed slightly reduces the use of human labor. But that is not enough to replace the role of humans in all stages of the agricultural sector activities. Not to mention the fact that the technology has not been fully accessed due to various limitations, such as procurement funds, mastery of technology and so on.

Minangkabau women are described as decorating Nagari (village). The placement of women is not just a symbol but is really given a role according to its position. Therefore women in adat have a place in making decisions at each meeting held in the village, even though they are not a person who plays a role in decision making. The placement of women as managers of inheritance heritage in Minangkabau is a form of attachment to Minangkabau women towards their large role in managing families but does not have the freedom to determine decisions (Suluah, 2004 in Nurti, et al, 2007). This also applies in determining policy decisions in food security.

Policies in the field of food security are an integral part of national development policies. Therefore, the strategy in building a food security system is not only oriented to increase productivity, but also to improve human resources through community empowerment in accordance with local wisdom so that people have the ability to fulfill their needs independently and sustainably. The ability of productivity of a region along with local wisdom that supports its utilization can be reduced the number of poor people who are food insecure.

The number of poor people who are vulnerable to food and vulnerable to the problem of food insecurity is still quite high. The main causes of food insecurity and poverty are the low incomes of the poor, resulting in reduced purchasing power, the limited ability of the community to access food; and limited assets and access to resources to develop micro-businesses. The main challenge in strengthening food security at the household level is to build the capacity and independence of the community to be able to overcome food problems that occur both within the household and in the surrounding community.

Nagari Koto Tuo, Limapuluh City District, West Sumatra, has a high number of underprivileged households, namely 72 households [2]. It was further stated that the poverty rate in the Limapuluh City district reached 16.19%. Based on the survey (2016) in the field, it was found about 98% of female farmer group members in Nagari Koto Tuo were sharecroppers with arable land of 0.1-0.2 ha so that it was categorized as small farmers. Many young people in the region are migrated, village endogamous marriages still tend to be maintained, patterns of relations between villages and migrants continue to be fostered, the life cycle tradition is still common so traditional social ties are reflected in the patterns of interaction and social relations in the environment. Relatives and communities are still relatively awake.

These poor people are at high risk and vulnerable to food insecurity. If food security management is not paying attention to this group, it will have an impact on increasing poverty/food insecurity and low nutritional status. Food insecurity occurs when certain households, communities or regions experience insufficient food to meet the standards of physiological needs for the growth and health of individual members. In relation to food security policies, even though women do not participate in making decisions, women (mothers) have authority in providing food in the family. In other words, national food security is created when food security at the family level is guaranteed.

Ellen R. Sauerbrey [3] suggests that many women in the world lack protection of their most legitimate rights are very poorly educated and very economically vulnerable. In many women countries also face social and cultural constraints to their progress, including discrimination, the need to balance family life and the need or desire to work outside the home, and the biggest obstacle of all is education.

Based on the description above, one of the focuses of development at this time is directed at addressing the problem of food insecurity or poverty by increasing food security. The program for building community food security is reducing rural poverty and the food needed at the household level. Food security is realized jointly by the community and government, and developed from the household level.

One of the government's programs in supporting the development of food security is a food independent village program. To measure the success of food self-sufficient village programs, it is important to conduct an analysis of community empowerment, especially women in the management of food independent villages based on local wisdom so as to create conducive socio-economic conditions towards independent and sustainability of food security.

## 2. Materials

Respondents from this study were female farmer groups in Nagari Koto Tuo, Harau District, Limapuluh Kota Regency. The research sample was determined purposively, namely all members of the farmer women's group total of 95 people. In this study also are used key informants and experts including community leaders, civil servants, agricultural agencies, local governments, and higher education institutions.

## 3. Method

Building the model of empowering women in sustainable food independent village management based on local wisdom with the System Dynamics method. System Dynamics modeling is the management of a complex, dynamic, non-linear system model and it has been feedback, using simulation assistive devices by applying the modeling cycle. The steps of the System Dynamics modeling cycle include creating concepts or structure of problems, modeling, data input, dimension consistency testing and simulation, and model validation, and ending with sensitivity testing and policy analysis [4].

The pattern of ecosystem changes with the change of its constituent variables based on time or dynamic. These changes result in system performance or work mechanisms that can be observed in their behavior. The simplification of the system mechanism can be made into a system dynamics structure that is a closed system with environmentally based systems that is possible to occur and external changes are considered as exogenous variables.

The problems discussed in this modeling are limited to factual issues related to the dynamics system model of causal relationships of feedback (causal feedback) between the productive land sub-system as the natural environment, sub-population system, poverty, health, institutions, local wisdom, empowerment, and income sub-system, expenditure represents the socio-economic environment. The main variables used in building a system dynamics model are given a definition or operational definition to facilitate the researcher to carry out the analysis.

The dynamics system structure is simplified into a causal loop diagram (cause and effect) called the simulation model, namely the system dynamics model to facilitate the work of systemic thinking. The model is a representation of the real world as a conceptual and contextual approach that tends to be more realistic, pluralistic, and holistic.

Variables in the dynamics system analysis method are grouped into two types, namely level (stock) and rate. Level states the condition of the system at any time or called the state variable system. The level is the result of accumulation in the system, while the rate represents system activity. The equation of a variable rate is a policy structure that explains why and how a decision is made based on the information available in the system. The rate affects the level.

The level is a quantity that accumulates based on time and rate is an activity or movement or flow that contributes based on changes per unit time in the level. Each variable will be defined in one

equation: level equation, rate equation, auxiliary equation or constant equation. The auxiliary equation is a charge calculated by a mathematical expression.

Factual conditions are stated in a causal loop diagram (CLD) and stock-flow diagram (SFD) which describes the relationship between the ecological sub-system and the socio-economic sub-system. Model behavior will be simulated so that future conditions can be predicted. Model sensitivity analysis and model intervention will be carried out for policy analysis in order to achieve the best goals. Definition of Operational Variables in Modelling in Table 1.

**Table 1**. Definition of operational variables in modelling

| No. | Variable | Operational Definition | Unit | Data type | Source |
|---|---|---|---|---|---|
| Sub-population system | | A dynamic balance between factors that add and factors that reduce the population. These factors are: | | | |
| 1. | Total population | The population of the study area | Person | Secondary | BPS |
| 2. | Birth | A number of births in the current year. | Person | Secondary | BPS |
| 3. | Mortality | A number of mortality in the current year. | Person | Secondary | BPS |
| 4. | Immigration | The number of residents comes to the study area in a certain year. | Person | Secondary | BPS |
| 5. | Emigration | The number of residents moved from the study area in the current year. | Person | Secondary | BPS |
| 6. | Birth-rate | Number of births per 1000 population | Person/1000 | Secondary | Data processing |
| 7. | Mortality rate | Number of mortality per 1000 population | Person/1000 | Secondary | Data processing |
| 8. | Immigration rate | Percentage of the population comes each year to the study area | Percentage | Secondary | Data processing |
| 9. | Emigration rate | Percentage of the population moving each year from the study area. | Person | Secondary | Data processing |
| Subsystem of agricultural productivity | | The amount of agricultural productivity is the total sum of various productions of food, fruit, plantation, forestry, livestock/fishery commodities multiplied by the price and minus the production costs with the following details: | | | |

| No. | Variable | Operational Definition | Unit | Data type | Source |
|---|---|---|---|---|---|
| 1. | Food crop production | Production of rice, crops, and vegetables | Rupiah | Secondary | BPS |
| 2. | Production of plantation crops | Production of hardy plants such as hazelnut, coconut, coffee, chocolate, areca nut, etc. | Rupiah | Secondary | BPS |
| 3. | Tree production (wood) | Production of forestry plants such as teak, mahogany, gamelina, lontar, etc. | Rupiah | Secondary | BPS |
| 4. | Fruit production | Production of fruit plants such as oranges, bananas, jackfruit, avocados, etc. | Rupiah | Secondary | BPS |
| 5. | Livestock production | Production of large and small livestock such as cattle, goats, horses, chickens | Rupiah | Secondary | BPS |

| | | | | | |
|---|---|---|---|---|---|
| The subsystem of Institutional Role | | | | | |
| 1. | Nagari fund | Total fund for community empowerment programs | Rupiah | Primary | Data processing |
| The subsystem of local wisdom | | | | | |
| 1. | Bundo Kandung Function | The trend of activities related to women's empowerment | No dimension | Primary | Data processing |
| The subsystem of women's empowerment | | | | | |
| 1. | Activity dynamics | The dynamic trend of KWT activities | No dimension | Primary | Data processing |
| Subsystem of poverty | | | | | |
| 1. | Poverty factor | Influential factors that are influential are based on the number of poor households | No dimension | Secondary | Data processing |
| 2. | Poverty trend Value | That qualitatively describes poverty trends | No dimension | Secondary | Data processing |
| 3. | Rate of poverty increase | The rate of increase in the number of poor households | Percentage | Secondary | Data processing |
| 4. | Rate of poverty reduction | The rate of reduction in the number of poor households | Percentage | Secondary | Data processing |
| Subsystem of income | | | | | |
| 1. | Total income | Total income from agroforestry productivity | Rupiah | Secondary | Data processing |
| 2. | Net income | Total income after deducting per capita expenditure | Rupiah | secondary | Data processing |
| 3. | Per capita expenditure | Per capita expenditure for consumption and agriculture | Rupiah | Secondary | Data processing |

## 4. Results and Discussion

Law No.32 of 2009 concerning Environmental Protection and Management states that the living environment is a system of the unity of space with all objects, power and circumstances, and living things, including humans and their behavior that affect the survival of the lives and welfare of humans and other living things. The natural environment is an ecological system consisting of sub-systems or components that are interrelated and form feedback (feedback loop).

The dynamics system model was built to determine the integration function of ecological, social and economic functions. In accordance with the concept previously stated, the sub-system presented is an independent village productivity sub-system as an ecological environment, a KWT empowerment sub-system, institutions, local wisdom, KWT income, poverty, and population as a socio-economic environment. Factual conditions are stated in CLD in Figure 1.

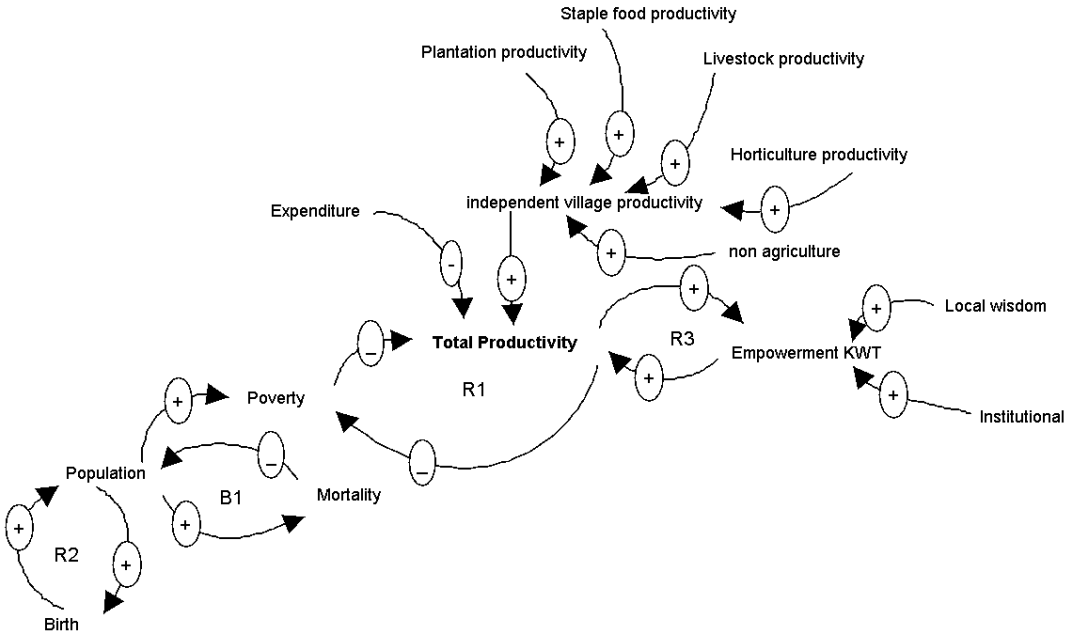


**Figure 1**. Causal loop diagram (CLD) women's empowerment model

In Figure 1 is explained that agricultural commodities which include food, plantations, horticulture, livestock, and other farming are the total income of KWT households that illustrate the productivity of independent villages. Increased income will be reduced by poverty. Likewise, the declining income will be increased poverty.

The population sub-system has two loops, namely one positive loop (R1) and one negative loop (B1), by forming a loop, each element is providing feedback. In R1 is illustrated that births are caused positively (unidirectional relationships) by crude birth rates lead to a large increase in the number of births. Thus the relationship between population and birth is reinforcing (R2).

Loop B1 illustrates that deaths are caused positively by gross mortality rates thus cause a decrease in population. Thus the relationship between population and death are balancing (B1). In the sub-system of poverty, the amount of poverty is also caused by the population but does not form loops. That is, an

increase in the number of people causes an increase in poverty, with each one is being positively affected by the rate, but the relationship does not mutually cause mutual effects.

The independent village sub-system has one positive loop (R1), by forming loops, each element provides feedback. Loop R1 illustrates that the increase of income is positively generated (unidirectional relationship) by an increase in the independent village sub-system.

Overall, the causal loop model in the population relations system, independent villages, KWT empowerment, income, and poverty can be illustrated that there are 2 loops of reinforcing and 1 loop balancing in the system. Between population sub-systems, KWT empowerment sub-systems, independent village sub-systems, income sub-systems, and poverty sub-systems in general there is a causal relationship that balances feedback, if one sub-system is uncontrolled, it will occur causal feedback negatively (in opposite directions) so that it will be reduced the existence of one sub-system with its constituent elements.

Based on the CLD created, then a model structure called Stock Flow Diagram (SFD) or flow chart is built, it can be seen the dynamics system model of the causal relationship feedback empowerment of KWT, independent villages, population, income, and poverty.

In the flow chart, it can be explained that the population sub-system consists of elements of the population that functions as a level/stock variable that gets an inflow from the elements of birth and immigration, and the outflow from death and emigration. Births get information from the population and crude birth rates, mortality gets information from crude mortality. Model simulations have described the behavior of the dynamic model are shown in graphs and time tables after Based the model is run based on the available Powers 2.5 Program. The simulation results can be explained as follows:

Migration gets information from the rate of immigration and emigration to get information from the rate of emigration and neither gets information from the population because migration is not directly affected by the population. These conditions lead to exponential balance and growth.

Based on the assumption that there was no disaster that could cause population shocks up to 2038, the initial population data was used in 2013 data from BPS, and variable operations, the model above was run so as to produce a simulation is presented in Table 2.

Based on the simulation, it can be explained that the population of Nagari is predicted to increase steadily (growth) from 2013 to 2035, but its growth is relatively low considering that empirically the population growth is only 0.6% in 2013. The prediction of the population can be used to project and make decisions various things both short and long term.

Birth (birth rate = 0.2%), is an element of population growth that is more real than immigration (rate = 1.98%), while the element of emigration (rate = 0.02%) is an element of population reduction that is more real than with death (mortality = 0.18%).

On Table 2 it can be seen that up to 2038 there has been no doubling of the population. The total population in 2038 is estimated at 10,701 people. Model validation test (Average Mean Error/AME) is done by testing the performance validity or output model, which is seeing how the output model behavior is in accordance with empirical data.

**Table 2**. The population of Nagari Koto Tuo from 2014-2038 based on reference data and simulation results

| Year | Total Population Reference | PopulationSimulations (People per Year) |
|---|---|---|
| 2014 | 7606 | 7753 |
| 2015 | 7682 | 7860 |
| 2016 | 7753 | 7969 |
| Average | 7680.33 | 7860,67 |
| AME = | 2,34% | |

BPS (2017) and Simulation Result

Independent village productivity is KWT's total income from food production, plantations, fruits, forestry, and livestock/fisheries. Productivity is the result of agricultural production, total area of productive after multiplying the price and deducting production costs. The calculation of total income is presented in Tables and Figures.

Interventions are carried out with the aim of increasing KWT household income so as to reduce poverty. An alternative intervention that will be carried out as functional intervention. Functional intervention is an intervention in one or two parameters (constants) or a combination of certain parameters in a model that is considered sensitive [5].

Each intervention will produce several future scenarios. Based on the simulation results from various scenarios, the best scenario will be chosen. The best scenario is a scenario that provides the best solution and it is still acceptable (make sense) in accordance with the purpose of the intervention. As previously stated, functional intervention in this study was carried out on KWT empowerment parameters by increasing local institutional funds/local wisdom (Rp. 70.000.00, 00/year) and so that KWT participation (KWT empowerment rate) to 80%.

Long run simulation behaviour scenarios are presented in Figure 4 and Table 3. It is explained to increase the role of women through KWT empowerment and institutions will be increased total income from KWT households (Table 3).

**Table 3.** Table of Time Simulation of Total KWT Revenues per Month without Intervention and With Interventions (KWT 1).

| Time | KWT_Total_Income | KWT_Total_incame_1 |
|---|---|---|
| 2,014 | 61,512.04 | 3,027,150.49 |
| 2,015 | 433,722.58 | 4,020,991.60 |
| 2,016 | 750,363.10 | 1,984,920.36 |
| 2,017 | 1,108,011.04 | 3,265,913.39 |
| 2,018 | 1,445,561.73 | 5,133,044.56 |
| 2,019 | 1,779,236.22 | 6,674,792.83 |

In Table 3 it can be seen that increasing total KWT income is due to the allocation of Nagari funds intended for transformation programs of knowledge and skills of Nagari women. The model is simulated from 2014 to 2038 with the condition of each variable in the model according to the real conditions (without intervention). Simulation results in the form of graphs that is illustrated the real behavior for increasing KWT empowerment will be reduced the number of poor families. Graphs of simulation results are presented in Figure 2.

The simulation chart above explains that empowering KWT through increasing the Nagari funds are allocated to institutions and the role of Nagari women (local wisdom) will be reduced the number of poor families. Decreasing the number of poor families is bigger with an intervention (2) than without intervention (1).

The result is the same as the opinion of Byrlee & de Janvry [6] stated that gender mainstreaming plays an important role, especially agricultural development. Further explained that in the perspective of growth and equity in agricultural and rural development, aspects of gender mainstreaming play an important role, especially agricultural development.

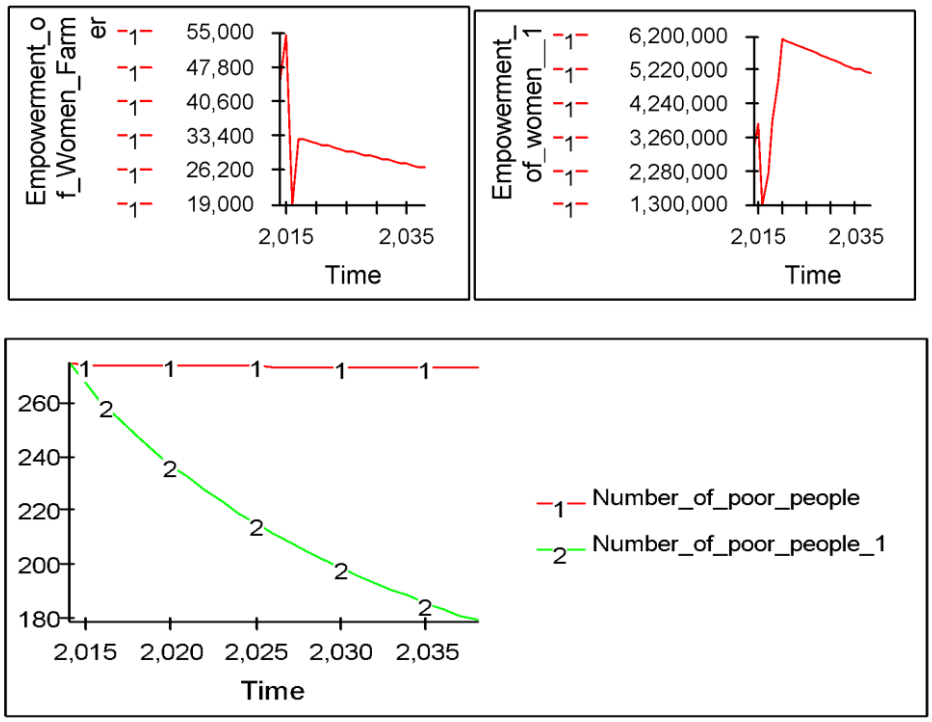


**Figure 2**. Graph of Time for Model Simulation without Interventions (1) and Functional Interventions (2).

Neglecting the field of agricultural development will have be serious consequences related to loss of production and income of agricultural households. Similarly, the high level of poverty, malnutrition, and food insecurity. This is due to the absence of gender-based policy guidelines. Gender-specific constraints are related to agricultural development include limited participation and women's access to productive resources, credit markets and discrimination in wage rates. These things can be limited to their potential role in revitalizing agriculture as a major way out of poverty.

Strategic policies and programs for gender mainstreaming in promoting optimization and accelerating development and agricultural growth need to be considered, including gender equality; market access and public counseling; education and training to access employment opportunities for women workers; elimination of discriminatory regulations that hinder the role of women; and the promotion of the role of women in public and private organizations in the agricultural sector.

The empirical study of the Socio-Economic Research Center of the Department of Agriculture (1995) in BPS and Bappeda DIY [7] was conducted in seventeen provinces in Indonesia, concluded that there were six main factors causing poverty, namely: (1) The low quality of human resources, this is indicated by low levels of education, high dependency rates, low levels of health, lack of alternative employment, low work ethic, low skills and large numbers of family members. (2) Low physical resources, this is indicated by the low quality and production assets and working capital. (3) The low application of technology, its characterized by the low use of agricultural mechanization inputs. (4) The low regional potential which is characterized by low physical potential and regional infrastructure. (5) Inadequate policies put forward by the government in investment in the context of poverty alleviation and (6) Lack of existing institutional roles.

Tuti, Gantini's research [8] in the two sub-districts, namely Kasepuhan Ciptagelar in Sirnaresmi Village, Cisolok Subdistrict, Sukabumi Regency and Kampong Naga in Neglasari Village, Salawu District, Tasikmalaya District described that was taking into account aspects of local wisdom provides a better picture of food security. The accuracy of measuring food security in the region has implicated

for the accuracy of determining the direction of development policies for food security.

Thus it is necessary to: (a) pay attention to the values of local wisdom that is still strong and maintained by local communities, reflected in the existence of sustainability efforts in aspects of their lives. In connection with this, agricultural development with a sustainable development paradigm that has been proclaimed needs to be implemented in all aspects of life, (b) the values of local wisdom that can be viewed as social capital, should begin to be considered to be taken into account in every step of preparing agricultural development policies, and ( c) Indicators in the aspect of local wisdom are very dependent on the specifications of the region, so that it is possible to have other indicators in different regions.

## 5. Conclusions

The leverage variables are the participation of women farmers (KWT) and institutional/local wisdom fund, which intervened in the sustainability scenario as policy analysis. Increasing the 80% participation of KWT in empowering women farmer's thus supporting the institutional and local wisdom fund (Rp. 70.000.000,00/year) can be increased the KWT household welfare and reduced the poverty rate.

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