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Achieving sustainable agriculture through enhancing agricultural extension institution

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Abstract. Agricultural extension system is an establishment to improve farmers' access to various assets for enhancing their capability. This research aimed to explore the link between sustainable agriculture and agricultural extension based on the conditions of farmers' livelihood strategies. The research was carried out in Jember Regency, East Java, Indonesia and designed with a qualitative approach. By using the Sustainable Livelihoods Framework, it will provide the real and complete picture of the reality of farmer daily life. Related to sustainable agriculture, the efforts that have been done by farmers are far from ideal. Farmers' capital assets that support their livelihoods are natural and physical resources. Agricultural extension system in the research location has overlooked by government extension with personal, group and mass approaches. Strengthening the agricultural extension system is to achieve sustainable agriculture. It is necessary to recognize the condition of mastering the five assets of farmers' capital. Improving the quality of life of farmers through livelihood strategies is also important, including integration of the concepts of resilience and persistence about farmer capacity. Synchronization of stakeholders from agricultural counselling and building strong institutions with information technology can spread knowledge and experience to farmers quickly, precisely, effectively and efficiently.

1. Introduction

Sustainable agriculture discourses some broader ecological, economic and social and political dimensions [1]. The central alarms of the ecological aspect are to diminish negative ecological and health externalities, to improve and practice local ecosystem resources, and preserve biodiversity. Economic dimensions pursue to ascribe value to ecological assets, and also to include a longer time frame in economic analysis. Social and political dimensions concern on the equity of technological change. At micro level, agricultural sustainability is related to farmer participation, group action and the promotion of local institutions, culture and farming communities. At macro level, the concern is for permitting policies to reduce poverty in developing countries and diet management in industrialized countries.

Agriculture is a different economic sector since it directly influences many of the assets, on which it depends on for success. Agricultural systems at all stages bank on the value of services flowing from the total stock of assets that they influence and control. Thus the five types of asset, natural, social, human, physical and financial capital [2], are recognized as being important [1]. Environmental goods and services are produced by natural capital, and this capital is the source of food (both extractive and generative), wood and fiber; water supply and regulation; treatment, assimilation and decomposition



of wastes; nutrient cycling and fixation; soil formation; biological control of pests; climate regulation; wildlife habitats; storm protection and flood control; carbon sequestration; pollination; and recreation and leisure. Social capital generates a flow of mutually beneficial collective action and contributes to the cohesiveness of people. Human capital is the total capability in individuals, based on their standard of knowledge skills, health, and nutrition. Physical capital is the store of human-made material resources, and comprises buildings, such as housing and factories, market infrastructure, irrigation works, roads and bridges, tools and tractors, communications, and energy and transportation systems, that make labor more productive. Financial capital serves as a facilitating role rather than as a source of productivity in and of itself. Hence, sustainable agricultural systems tend to have a positive effect on natural, social and human capital, while unsustainable ones deplete these assets, leaving fewer for future generations.

Agricultural development is often identified with working with technology, so the problem is how the farmers want to adopt the technology [3]. But the reality is that few farmers have adopted these innovations. They appear to have been produced as suitable largely only for research stations, with their abundant supplies of labor and resources and standardized soil conditions. Agricultural sustainability is not only simple models, but it should be understood as a process of social learning, and developing technologies tailored to specific local conditions. This focuses on improving the capacity of human resources and their communities to learn about the complex ecological and biophysical complexity in their fields and farms, and then to act on this information. The process of learning, if it is socially embedded and jointly engaged upon, provokes changes in behavior and can bring forth a new condition.

Sustainability, ecosystems and natural resource management are the challenges for farmers and agriculture [3]. This is directed to a demand for agriculture to become less exploitative and more 'sustainable,' which means that agriculture will have to be supported to make the best use of available natural resources and inputs, and redevelop conditions for future. Sustainability cannot just be looked at in biophysical or ecological terms, because the state of 'hard systems' is contingent crucially on interactions between multiple human beings as the 'soft system.' To summarize, if agricultural branches become more sustainable, farmers and other stakeholders will have to take into account and link inherently complex knowledge regarding both global and local processes and environments.

Critical factors to be explained are the various strategies and aspirations that farmers may have concerning their social and natural environment, as well as variations in the way they organize their livelihoods and in the role agriculture plays concerning non-agricultural activities. Some farmers may prefer to organize their farms relatively independent from input markets, while others do not mind buying in external inputs. Similarly, some entrepreneurial farmers like to work on a large scale resulting in bulk production, while others take advantage of their craftsmanship and occupy on a smaller scale, worth production [3].

To achieve sustainable agriculture as new paradigm in agricultural development, it is vital to identify processes that could change conventional farming practices. Actors and stakeholders involved also need to be seen the status and role as well as the relationship between them to ascertain whether it has worked well to achieve sustainable agricultural goals in the environmental, social and economic aspects. Farmers as the main actors must also ensure the conditions of control and access to assets in their livelihoods to change towards sustainable agriculture. This study aimed to explore the link between sustainable agriculture and agricultural extension based on the conditions of farmers' livelihood strategies.

2. Methodology

This research was located in Jember Regency involving one sub-district in southern (Ambulu) and one sub-district in northern (Jelbuk). These sub-districts represent different ethnic and agroecological backgrounds. Most farmers in Ambulu are Javanese, on the contrary farmers in Jelbuk are mostly Madura ethnic. Agroecology in Ambulu is lowland and technically irrigated, while Jelbuk is a highland and tends to dry land.

The research was designed with a qualitative approach, which means for exploring and understanding the meaning individuals or groups ascribe to a social or human problem[4]. By using case studies strategy, the researchers have explored in depth agricultural extension program in Jember Regency at first semester of 2018. Data were collected with in-depth interview by protocol guide from 17 farmers and six extension officers. Observations and documents were also carried out to complete the data from the interviews.

The collected data then analyzed with following steps [4]: (1) the data was organized and prepared for analysis; (2) all the data was then read; (3) detailed analysis with a coding process; (4) using the coding process to generate a description of the setting or people as well as categories or themes for analysis; (5) advancing how the description and themes will be represented in the qualitative narrative to convey the findings of the analysis. Although the steps seemed to be a linear, it conducted as more interactive in practice; the various stages are interrelated and not always visited in the order presented.

3. Results and discussion

3.1. Sustainable agriculture practices

For instance, The National Integrated Pest Management (IPM) Program in Indonesia is a unique case study of work to promote more sustainable agricultural practices [5]. It has tried with alternatives that we cannot disregard. What makes it particularly interesting from an extension science is that it has deliberately tried to improve adult education approaches that fit the requirements of IPM. Few projects or program have that capacity. The Program has experimented on a scale that goes beyond the usual pilot project, and done so within the setting of government institutions. It allows some observations that can shape the perspectives of policy makers, research and extension administrators and voters as they try to learn their way to more sustainable futures.

Regarding sustainable agriculture practices, the efforts that have been done by farmers are far from ideal. Regarding knowledge, farmers have received material on sustainable agricultural concepts such as LEISA, organic fertilizers and biological agents for pest and disease control. Then regarding their attitude recognize and agree on the benefits of sustainable agriculture, especially in the long term. But for their behavior is still not consistent, especially when in the transition period they experience a shock decline in production.

The use of superior seeds by farmers whose crops cannot be used as seed is an unsustainable practice of agriculture. In the long term, they become dependent on seed companies. Also, this threatens germplasm diversity. The existence of new varieties from outside the ecosystem also creates ecological imbalances and raises further disturbances.

The availability of production inputs such as chemical fertilizers that are still lacking is an opportunity to return to the concept of using minimal external inputs in agriculture. This opportunity can be achieved by using self-made organic fertilizer, in addition to being environmentally friendly and economical. The farmers already have the knowledge and skills to make organic fertilizer obtained from training in the farmer group. However, organic fertilizer is less practical and the effect on plants is not immediately visible.

The price of expensive pesticides is another opportunity to reduce chemicals that are at risk of leaving unhealthy chemical residues. Farmers are aware of the existence of natural and inexpensive alternatives in dealing with pests and diseases. In fact, they also practiced and acknowledged the results several times. It's just that when an attack occurs, they tend to panic and want to overcome quickly so that what is used is chemical pesticides. In short, the decision-making behavior of farmers is still short-term and prioritizes practicality.

One of the sustainable farming practices is double row planting system that regulates plants per unit area by arranging plant layout and expanding the influence of marginal plants and facilitating plant maintenance. Planting density is one of the important things in crop manipulation to optimize yield. Double row planting system is a transplanting system by making an empty passageway between

2-4 rows of rice plants, while the spacing in the row becomes half the spacing between lines. Many farmers already know, but only few adopt it.

In general, farmers in the research location are still cultivating with priority economic dimensions, compared to the natural and socio-political dimensions. They still use unnatural production inputs such as varieties that cannot be made into a seed back and fertilizers as well as chemical drugs. Consideration of environmental sustainability has not been thought and their behavior as their chemical residues. Social aspects such as consideration of human health as consumers are also not prioritized. Likewise, the political aspect in the form of regulations and standards of good agricultural practices are still not complied with.

3.2. Farmer's five capital assets

Mostly farming in Indonesia is peasant agriculture [4], which is mainly built upon the sustainable ecological capital and oriented towards defending and improving peasant livelihoods. Multifunctionality is often a major feature. Labor is primarily provided by the family (or mobilized within the rural community through relations of reciprocity), while land and the other significant means of production are family owned. Production is oriented towards the market as well as the reproduction of the farm unit and the family. The five capital assets are essential to be analyzed.

Based on the results of the analysis, the control of land by farmers in the study location ranged from 0.125 to 1.5 hectares with an average of approximately 0.38 hectares of land tenure. Most of the land is self-owned, but there are some of the land that is rented and little part is a profit-sharing system. The cropping patterns in one year reach three rotations. In the southern Jember the pattern is rice-rice-corn/ tobacco, while in northern Jember the pattern is rice-corn-corn/tobacco. Productivity of rice ranged from 780 to 9000 kg ha^{-1} , and productivity of corn ranged from 2000 to 12000 kg ha^{-1} . These conditions indicate that there are many variations regarding inputs and outputs as well as processes in farming.

Most of the interviewed farmers sold the whole harvest; only a few left the rice harvest to be processed and consumed by themselves: farmer revenue per season or about four months around 8.9 million IDR with average net income about 4 million IDR. They also felt that the harvest prices were not profitable and tended to be cheap even below the production price. On the contrary, the daily wage of labor working on their land must be paid relatively expensive ranged from 25,000 IDR to 70,000 IDR with an average 50,000 IDR per day.

Productive assets which most farmers have to run their farming were personal appliances such as mattock, sickle, pail, and flit gun. Only a few of them already have a water pump for irrigation. Even machines that used infrequently and expensive they often lease such as tractor and harvester. These assets sometimes are useless when they have farming activities done upon payment. But this ownership is still significant when they must do their farming by their selves for reasons such as no money for payment, no labor available and so forth.

Farmers abide at home with area ranged from 100 m² to 2,000 m² and building range from 54 m² to 357 m². Most of them acquire their property from inheritance. These variations indicate fragmentation, the trend of decreasing size and urban typically home. So, they are unable for planting horticulture or annual crops because of the narrow or absence of yard around their house. But almost all of their home is available for toilet facilities.

There are infrastructures around their home and farming area. The road is relatively close by their home with an asphalt coating and connected with bridges when through over rivers. Electricity is all set so is with telecommunication. Freshwater is supplied from their well. The market for consumer goods is also available near their home with relatively complete providing farmer household needs. Meanwhile, infrastructure that supports their farming like rice milling unit can be accessed easily.

The formal basic education facilities are relatively easily accessible to the children of farmers because the distance between primary and junior high schools with their homes is close, while the senior high school is relatively far away because it is in the center of the sub-district whereas non-formal education such as courses and training is almost not available to them. The only exercise for

farmers that is carried out in farmer groups is provided by extension officers, both public and private extension agents. It shows how important the existence of an extension system to increase the capacity of farmers.

3.3. Agricultural extension system

Agricultural extension service is one of the most common form of public-sector support of knowledge diffusion. An effective agricultural extension can connect the gap between research in the laboratory and changes in the individual farmer's fields. In addition to information about cropping techniques, optimal input use, high-yield varieties, and prices, extension agents can inform farmers about improved recording and aid in the development of their managerial skills, thus facilitating a shift to more efficient methods of production. By accelerating the diffusion process of improved technology, the extension can bring a faster growth of yields and rural incomes than in the absence of extension [6].

The agricultural extension system in the research location is dominated by public extension with personal, group and mass approaches. Also, there are also private extension agents called formulators from agricultural companies. Private extension agents use training and visiting approaches to farm fields. Community or independent activists are usually represented from farmer associations outside the farmer group. This extension focuses on issues related to meet the goals such as strengthen the bargaining power. The three types of extension agents are recognized in the extension system.

Public extension officers tend to achieve fulfillment of their duties compared to achieving good and sustainable agricultural practices. They have work areas and focus on group approaches rather than personal or mass approaches — the group that is the farmer group. The working area which covers approximately three villages can cover more than 30 farmer groups so that one farmer group only gets once occasion in a month or less with only about 2 hours in every meeting. The personal approach is only done if necessary, with an invitation from the farmers. While the mass approach is carried out in collaboration with private extension agents because of the limited resources in handling many participants. The form of group approaches that are often used is visiting and training because according to them this approach is the most effective and efficient.

Private extension agents are targeted to sell commercial products in their extension. In contrast to public extension workers, they often do personal and mass extension approach. A personal approach is made to key farmers so that they can affect other farmers with a promise to get a fee if the sale is reached. While the mass approach they are doing is more on a massive promotion in the form of farmer field day or FFD. Their company wants to show the success of agriculture that uses the input of their products. Even though they spend large costs, they consider that this type of activity can significantly increase sales turnover.

Independent extension agents who usually come from farmers' associations outside the farmer groups or from non-governmental organizations are less developed in the research location. Its existence is needed because its motives and social mission are more trustworthy in the development of the farming community. It's just that because of limited resources; the development is not significant. Also, because the focus on certain commodities makes their movement less flexible. In the future, this type of extension is needed to deal with the development of increasingly specialized farming communities.

3.4. Enhancing agricultural extension institution

Indonesia has employed both non-market and market reforms for agricultural extension system [7]. Non-market extension reform strategies realized through decentralization to lower tiers of government as stated in Indonesian Law No. 23 of 2014 on Local Government. Meanwhile, market extension reform has been implemented by pluralism through involving profit company/private and independent extension as stated in Indonesia Law No. 16 of 2006 on Extension System of Agriculture, Fishery and Forestry. Indonesia has undertaken reform through the 'deconcentrating' of authority to lower branches of central government. Central authority structure deconcentrated to field levels in some

ways: financial grants, local coordination, district administration, provincial development planning, and regional coordination. Assessment of farmer's five capitals is crucial.

Based on the conditions of control and farmers' access to assets that support their livelihoods about the achievement of sustainable agriculture they only received support from natural and physical resource assets. Three other assets, namely human, social and financial resources, are still under sufficient conditions to practice good and sustainable agriculture. Human resource assets need to be upgraded through informal education or courses and training. Social assets can be improved by increasing the intensity of farmers' social interactions between members and members of other groups while financial assets can be done by mediating between farmer groups and financial institutions.

The quality life of farmers is still in poor condition because their livelihoods still rely on the assets they have. Because the assets do not support the income from these livelihoods, of course, it does not meet the needs which result in poor quality of life. For this reason, it is necessary to develop livelihood strategies that can contribute to the income and quality of life of farmers and their families. This strategy besides intensification is diversification. Diversification of livelihoods can take the form of activities outside agriculture to utilize the surplus time that the farmer and his family have as labor.

Regarding sustainable agriculture, agricultural extension systems must include the concept of resilience and persistence. The resilience is the capacity of systems to buffer shocks, and stresses and the persistence is the capacity of systems to continue over long periods. Modern agroecosystems have weak resilience, and for transitions towards sustainability need to focus on structures and functions that improve resilience. The persistence is a function of the intrinsic characteristics of the agroecosystem, of the nature and strength of the stresses and shocks to which it is subject, and of the human inputs that may be introduced to counter these stresses and shocks [1].

When preparing agricultural extension, the agents must have a fairly clear idea about who is organizing it for. In other words, they cannot effectively anticipate an audience without having some insight into those who make up that audience. At the other side, actors and audiences with different characteristics need to be approached in different ways (i.e. with different kinds of activities) to help realize similar outcomes. In the context of an interactive process, the inherent idea is to bring together a variety of mutually interdependent stakeholders. In general, it is important to synchronize stakeholders of agricultural extension.



Figure 1. Integration of sustainable livelihood approach and agricultural extension stakeholders to sustainable agriculture

With the development of information technology, it is necessary to build an agricultural extension institution with good ICT connections, preferably through the internet, community radio or cellular phones. These can disseminate timely knowledge on experiences and options concerning seed and plant varieties, soil conservation and rejuvenation techniques, improvements in technology, attendant long- and short-term risks, costs, and benefits, levels of regulation, as well as market trends and price fluctuations. The main challenge with this impact evaluation is the (unobserved) differences in information provided via each mechanism [8]. For example, in-person visits might allow extension agents to show farmers how to use a new technology or technique, and different types of information will be provided during visits and discussions. Controlling for these differences is difficult or impossible unless the technical information and technology are very narrowly defined. While hotlines might be more useful for time-sensitive and technically simple inputs or techniques, they would be less useful for technologies that are more difficult to learn or use.

As an illustration, strengthening the agricultural extension system can be seen in Figure 1. Based on the conditions of five farmers' capital assets and synchronization of agricultural extension stakeholders both from farmers, the private sector and the government, sustainable agricultural goals in economic, social and environmental aspects can be achieved equally. The integration of the three concepts is expected to strengthen the functions of stakeholders including getting more excellent results.

4. Concluding remarks

Based on the previous discussion, this research could be concluded as followings: (a) farmers in the research location are still cultivating with priority economic dimension; (b) farmers' capital assets that support their livelihoods are natural and physical resources; (c) the agricultural extension system in the research location is dominated by public extension; (d) some efforts must be made to make synergy of enhancing for achieving sustainable agriculture.

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