ENVIRO: Journal of Tropical Environmental Research (2023) 25 (1): 1–11
URL: https://jurnal.uns.ac.id/enviro/article/view/78516
DOI: https://doi.org/10.20961/enviro.v25i1.78516

e-ISSN: 2963-1246

Critical Factors Determining The Adoption of Sustainable Upland Agriculture In Upland Lawu, Indonesia

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Received: February 1**,** 2023 **Published:** March 27, 2023

Abstract

Several sustainable farming practices have been introduced and have shown a low farmer participation. This paper scrutinizes factors behind the poor adoption of sustainable upland agriculture by engaging the DPSIR in combination with the framework of Capacity-Incentive and Environmental Degradation. This paper employed a simple random sampling method by applying a questionnaire to 408 farmers. We used multiple linear regression analysis to know the linkage between the predictor and the dependent variable. The resulted R-Square was 0.649, with the F *statistic less than 0.05. The regression model can explain the linkage between the proposed predictors and the dependent variable. Governmental incentive is the significant predictor affecting the adoption of sustainable upland agriculture. Ensuring the profitability of it by facilitating market channels, credit, and allocating subsidies for organic input are critical. Building human capital in agriculture through services is also critical in strengthening the upland farmers' confidence to adopt sustainable agriculture.*

Keywords: *Livelihood assets, Incentives, Sustainable upland agriculture*

INTRODUCTION

Sustainability, ratified as an international agreement during the World Summit on Sustainable Development in Johannesburg in September 2002, has to be adopted as a basis for any development sector, including agriculture. Therefore, planners and decision-makers worldwide have been forced to create policies and strategies that align with sustainable agriculture criteria (Azar *et al.*, 1996; Rigby and Caceres, 2001). However, despite its appropriateness, the idea of sustainability has faced a big challenge since difficulties are found during its operationalization. While a balance must be sought among the three dimensions of sustainability, the economic and social dimensions often dominate over ecological sustainability.

Upland agricultural area bears uniqueness related to its potential capital for economic development and its susceptibility to environmental degradation. In addition to its potential to support economic and social development (Haryanto, 2004; Arshanti *et al.*, 2007), upland areas also have several specific ecological properties that must be conserved for critical ecological reasons (Haryanto, 2004). Mismanagement in the upland area may bring negative ecological externalities to the rural economy and society. In addition to its potential capital, upland areas are

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Cite this as: Karyanto, P., & Hanapi, M. (2023, March). Critical Factors Determining The Adoption of Sustainable Upland Agriculture in Upland Lawu, Indonesia. *Enviro: Journal of Tropical Environmental Research, 25(1)*, 1-11. doi: https://doi.org/10.20961/enviro.v25i1.78516

inhabited by rural farming societies with specific socioeconomic characteristics that must be addressed since these properties determine how upland farmers make agricultural decisions (Altieri, 2002). Indeed, sustainable upland agriculture should focus on increasing agricultural yield and considering ecological conservation criteria appropriate to the upland farmer's socioeconomic characteristics.

The government of Indonesia has made considerable effort to address the sustainability of upland farming. The former president committed to adopting the three sustainability pillars in the agricultural program (Yudhoyono, 2006). Since then, agricultural sustainability has translated into several forms of environmentally-friendly agriculture, for example, the low external input agriculture/LEIA (Reijntjes, 2003), organic farming (Husnain *et al.,* 2003; Apriantono, 2007), prescriptive farming (Notohadikusumo, 1999; Makarim, 2005) and farming under the Integrated Pest Management Program (IPM). Upland farmers have been urged to implement environmentally-friendly agricultural practices to make upland agriculture more sustainable. However, diffusing these forms of sustainable agriculture never goes without obstacles. Despite all this effort, unsustainable practices persist in upland agriculture. The critical question, therefore, is to seek the determinant related to the low level of adoption of sustainable agriculture by upland farmers and factors affecting farmers' decisions and behavior. This paper aims to determine the critical factors affecting the upland farmer's decision to adopt certain sustainable agriculture practices. This paper used the framework of Driving-Forces-Pressure-State-Impact-Response/DPSIR of the UN (EEA 1999; Kristensen, 2004) and emphasized the driving forces and pressure. In this paper, the driving forces were translated into five types of livelihood assets (Bebbington, 1999; Bahamomondes, 2003; Swinton *et al.*, 2003; Fernandes, 2004) and *incentives* (Reardon and Vosti, 1995).

METHODS

This research stood on a quantitative paradigm. This research was conducted in sub-districts Ngargoyoso (7O35”.S; 111O7”..E) and Tawangmangu (7O40”..S; 111O7”..E). We sampled the upland farmer within these two sub-districts as a representative upland area surrounding Mount Lawu (Figure 1). Samples were taken randomly from 408 upland farmers through a five-scaled Likert questionnaire. The questionnaire was used to measure the extent of the five types of rural capital/ capacity, i.e., social capital, human capital, physical capital, financial capital, and natural capital, as well as the level of incentive. These five types of capital and incentive were the independent variables used in this research. As the extent of agricultural degradation has resulted from the farmers’ decisions, we used a valid and reliable questionnaire to assess their decisions as a dependent variable. The data from the questionnaire was fixed to fulfill all the assumptions for the regression analysis. We analyzed the questionnaire result using correlation and linear regression analysis using SPSS to have a regression model showing a linkage between capacity/incentives and agricultural degradation.

Figure 1. Mount Lawu, Central Java Indonesia. The research site is located at the upland area at $7^{O}35$"..S; $111^{O}7$"..E) and $7^{O}40$"..S; $111^{O}7$"..E. Source: http//www.pu.go.id.

RESULTS AND DISCUSSION

Results

The R square of regression analysis of linkage between the predictors and the extent of the adoption of sustainable upland agriculture is presented in Table 1.

Table 1. The R square value. The value of R square is 0.649; the F statistic is = 105,714, with the p-value less than 0.05.

Model Summary[b]

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Durbin-Watson
1	.806[a]	.649	.643	2.28516	1.304

a. Predictors: (Constant), Governmental Incentive, Market signal, Physical capital, Social capital, Financial capital, Natural capital, Human capital

b. Dependent Variable: Decision

The R square value is 0.649, indicating that the regression performed well. More than 60% of the dependent variable is explained linearly by the independent variables. The overall independent variables can adequately predict the change of the dependent variable. The Beta standardized coefficient is given in Table 2. Beta standardized coefficients indicating the unique effects of each independent variable on the dependent variable are presented in Table 2.

Table 2. The coefficient table of the regression analysis of the association between five livelihood assets and the extent of adoption of sustainable upland agriculture.

	Unstandardized Coefficients		Standardized Coefficients			Collinearity Statistics	
Model	B	Std. Error	Beta	T	Sig.	Tolerance	VIF
1(Constant)	12.488	1.560		8.007	.000		
Soc.capital	.033	.014	.093	2.369	.018	.574	1.742
Human capital	.234	.038	.296	6.191	.000	.383	2.608
Financial capital	.071	.026	.110	2.771	.006	.555	1.803
Physical capital	.284	.041	.226	6.927	.000	.820	1.219
Natural capital	-.149	.036	-.181	-4.153	.000	.460	2.173
Market signal	-.092	.065	-.054	-1.415	.158	.612	1.634
Gon. incentiv	.483	.046	.446	10.520	.000	.488	2.049

Table 1 shows that, of the five chosen predictors, most are significantly associated in a positive direction with the application of sustainable upland agriculture: social capital (0.93; p = 0.018), human capital (0.296; p = 0.000), financial capital (0.110; p = 0.006), physical capital (0.226; p = 0.000). Natural capital (0.181; p = 0.000) is significantly associated with applying sustainable upland agriculture in a negative direction. Market signal (0,054; p = 0.158) affects the farmer's decision in a negative direction and considered insignificant.

Disucssion

Linkage between Five Types of Livelihood Asset and Sustainable Upland Agriculture

The toxic triangle theory (Levins, 2006) suggests that lack of access to capital or poverty may lead to environmental degradation and the unsustainable exploitation of natural resources. Poverty can be defined from several perspectives. The popular definition of poverty is related to welfare poverty. The definition may be inappropriate when applied to the upland farmer. According to the welfare definition, farmers' households that are not poor may still suffer from investment poverty since they lack sufficient valuable assets to invest in sustainable agriculture. Here, valuable assets are defined as a farmer's access to five livelihood asset/capital types or *capacities* (Swinton *et al.*, 2003).

Capacity consists of five livelihood asset types: social, human, financial, physical, and natural capital (Bebbington, 1999). Several reviews on these five types of livelihood assets have acknowledged their importance as factors that affect people's decisions regarding natural resource-based activities and the degree of environmental degradation (e.g., Bebbington, 1999; Bahammondes, 2003; Swinton *et al.*, 2003; Fernandes, 2004). These five livelihood assets are essential for upland farmers' decisions to adopt sustainable agricultural practices (Karyanto and Hanapi, 2009). The regression analysis of the association between the five types of livelihood assets and the extent of the application of sustainable upland agriculture resulted in a coefficient table as follows:

Social capital refers to the value of trust and connectedness between people. Trust lubricates cooperation and encourages social obligation. A set of so-called 'rules of the game' may emerge based on a collective agreement: the common rule, norm, and sanction. Individual actors then have the confidence to act in line with collective activities. Social capital is characterized by three types of connectedness: bonding, bridging, and linking. Social capital involves four aspects: relation/trust; reciprocity and exchanges; rules, norms, and sanctions; and connectedness, network, and group (Pretty, 2003). Social capital is likely essential for successfully implementing government plans, regulations, and policies (Fernandes, 2004). Indeed, the low level of social capital can make the regulations and other government policies fail, have a low result, or only have short-term effects on farmer attitudes and behavior (Hasbullah, 2006).

Trust is an essential pillar of social capital. In terms of upland agriculture, trust can lead to better cooperation in adopting sustainable agriculture. Therefore, a greater level of trust can make upland farmers more confident in taking concrete collective action in adopting sustainable agriculture into their activities. Trust builds farmers' confidence to undertake collective activities if they know that others will do the same. Indeed, trust is still critical in affecting the decision of upland farmers to adopt sustainable agriculture in their farming activities (Karyanto and Hanapi, 2010).

Despite the importance of trust, it cannot sufficiently drive farmers' decisions to adopt sustainable upland agriculture. Connectedness is also essential. Connectedness facilitates the diffusion of the governmental program for sustainable agriculture. However, there is evidence that the degree of connectedness of the upland farmers is limited to their local communities (bonding type of social capital). Hence, the farmer still has narrow access to external information and cooperation. It means that information and government programs will be considered less effective when their diffusion is limited to only a restricted larger community scale. Diffusion agents or *kader* may be of solutions. However, even though the farmer's level of trust is considered high, the *kader* still faces difficulties persuading upland farmers to change their farming habits.

Another factor associated with farmers' decision-making is human capital, which is the total capacity of an individual. It is based on personal knowledge, experience, skill, health, and nutrition (Pretty, 2003). Education, knowledge, and skills are critical aspects of building human capital; therefore, education and training are important in developing good human resources in agriculture (Soukup, 2007). Education also helps people make informed decisions (Rizov, 2001). Education plays a significant role in smoothing and enhancing the flow of information and innovation during the process of transferring skills and knowledge. Indeed, a more educated farmer can do better than a less educated one. Education is also vital in helping farmers decide how to manage their farmland. Educated farmers are more likely to be innovative and take up information and are more likely to be open to new ideas. Educated farmers are also more likely to take the initiative and set up their farms. Indeed, education and training can give farmers more personal competitive value, allowing them to access off-farm jobs. Education and training help to diversify the way they make their living and offer opportunities for better financial capital.

Formal education and training are also crucial in building farmers' attitudes toward the environment, and strengthening human behavioral ecology is vital in making farmers more aware of environmentally-friendly methods (Cronk, 1991). Institutionalizing environmental attitudes helps build appropriate knowledge in farmers about needs, values, and goals, which, in turn, can lead to action (Notohadiningrat, 1993). However, institutionalizing attitudes or extending change agents are not the only ways to change or improve a situation. According to the Theory of Planned Behavior (Ajzen, 2001), institutionalizing environmental attitudes can facilitate changes in attitude and build subjective norms expected to affect how farmers work.

Financial capital can determine farmers' decisions. Undoubtedly, financial capacity supports any production system, including agriculture. Evidence shows that upland farmers' livelihood and financial source depends on natural resources. Since upland farmers invest in the agricultural sector, they focus on how to optimize production and minimize risks for production and marketing. Therefore, upland agriculture has changed from a subsistence to an activity of earning money.

When upland farmers adopt sustainable agriculture, they calculate the costs and benefits they face. The low yield of environmentally friendly agriculture will be less attractive to farmers, as they expect greater yields to make more financial gains. From the perspective of financial security, these less desirable agricultural practices pose a greater risk, as yields may be under threat. Indeed, upland farmers place great importance on their financial security, which they equate with avoiding low-yield agricultural practices. Hence, when other occupations or sources of income are inaccessible or only in limited supply, upland farmers will not be interested in this type of low-yield agriculture. In addition, organic farming, one of the environmentally-friendly agricultural practices strongly recommended by the government, requires a more financial investment than conventional agriculture. Because subsidies for organic input are less available, manufactured organic input is sold at a higher price. Since markets for organic farming in Indonesia are still uncertain, upland farmers will be reluctant to engage with it as it may be regarded as high risk.

Accessible credit and subsidy for manufactured organic input could be beneficial in overcoming the above financial problems. Accessible soft credit could give farmers more opportunities and capacity to diversify their livelihood and improve their financial security. Subsidies would make organic input cheaper for upland farmers and make them more confident in engaging in organic farming, as the production risk would be minimized.

Financial capital is strongly correlated with physical capital. Physical assets comprise capital created by economic production processes (Pretty, 2003). Physical capital also includes buildings, infrastructure, goods, and services created, purchased, or borrowed by people associated with the farm to facilitate their exploitation of natural resources for agricultural production (Altieri, 1987). The availability of subsidized, manufactured organic fertilizer is considered critical in improving the diffusion of sustainable upland agriculture and organic farming. Indeed, when organic fertilizer from livestock is inadequate, manufactured organic fertilizer becomes an alternative. However, when this manufactured fertilizer is sold at high prices, subsidies are needed to make it accessible.

Natural capital is slightly different from other types of capital. It is exploitable and is vulnerable in terms of its quality and existence. Natural capital including both material and immaterial resources provided by nature (Altieri, 1987). Land, water, biodiversity services, and climatic conditions are examples of natural capital affecting upland farmers' decisions. Natural capital may be negatively associated with farmers' decisions. As people who live close to their property, upland farmers recognize the strengths and weaknesses of their land. They know that the steeper land's unique ecological properties must be conserved to sustain production. However, upland farmers are more likely to maximize their exploitation of this type of capital, meaning they have become bold enough to ignore the ecological risks they will face. This phenomenon shows that 'the balance between economic orientation and environmental concerns has shifted to a point where a tendency toward profit dominates agricultural activity.

Linkage between Incentive and Sustainable Upland Agriculture

Capacity is critical for the adoption of sustainable upland agriculture. However, while *capacity* is essential in farmers' decision-making, behavior, and sustainable agricultural activities, it is still insufficiently driving farmer decisions. Farmers must consider that they have an *incentive* to invest in sustainable practices. Incentive encourages the farmer to make a farming decision. It involves signals the farmers receive from the market, public policy, institutions, and farmer's organizations/NGOs (Bahamondes, 2003). Incentives affect farmers' behavior by building their confidence and giving them the

courage to do sustainable practices at the center of their farming strategy. Indeed, incentives can affect how farmers make particular decisions in terms of agricultural management.

According to Bahamondes (2003) and Swinton *et al.* (2003), the results of the applied Reardon and Vosti framework differ for different levels of assets and different eco-regions. Market signals may not be associated with farmers' decisions to adopt sustainable upland agriculture. A reasonable explanation for this result may be related to natural capital. The extreme climatic conditions and high humidity in upland areas only allow certain types of cultivation and specific crops. In other words, farmers do not always respond directly to market signals.

The extent to which upland farmers take up sustainable agriculture is heavily associated with the degree of government *incentive* they consider they receive. The policies, services, and assistance provided by government institutions and NGOs play an essential role in how confident and boldly upland farmers are in incorporating sustainable agriculture into their practices. Therefore, government policies are an external factor affecting upland farmers' decisions and should be well designed for *incentives*. Good *incentives* help control the farmers' behavior and make them more willing to engage in environmentally- friendly practices, leading to sustainable upland agriculture (Ajzen, 2001). According to Parson (1975) and Mead (1972), incentives also contribute to farmers' self-respect and encourage them to adopt more sustainable practices.

Even where capacity plays less of a role in farmers' decision-making, *incentives* can still be considered an issue. Indeed, generally, it is considered that government *incentives* are still failing to build farmers' self-confidence sufficiently or drive their willingness to adopt sustainable practices. Though the government of Indonesia has promoted organic farming since 2000 and launched the plan 'GO ORGANIC 2010' (Apriantono, 2007), many problems involving organic and environmentally-friendly agricultural products remain unresolved. There are some weaknesses associated with government *incentives*. *The first* involves the market channels for agricultural products from organic and other forms of environmentally-friendly agriculture, and this issue is found at local to national levels. There is evidence of unfair competition between organic agricultural products/products from other forms of environmentally-friendly farming and highly subsidized non-organic products in the same local marketplace. The uncertainty of the marketplace for organic products is one of the reasons that upland farmers are discouraged from adopting organic and other environmentally-friendly farming practices. Indeed, organic agricultural products are sold at the same price as non-organic agricultural products at local markets. When yields from organic and environmentally-friendly farming are smaller and sometimes lower quality than non-organic yields, organic farming and other forms of environmentally-friendly agriculture lose their capacity to compete. Farmers prefer to produce non-organic food, as yields are higher and are easy to sell at markets without any extra investment.

These market-based problems with organic farming and many other forms of environmentally-friendly agriculture affect local farmers, local government, and national government. Most organic products from Indonesian farmers do not pass the Indonesian SNI standard for organic products (Standard Nasional Indonesia/National Standardized Products of Indonesia), nor do they fulfill the standards set out in the Guideline for the Production, Processing, Labeling, and Marketing of Organically Produced Food, CAC/GL 32-1999, used by IFOAM (International Federation for Organic Agricultural Movement). It means organic products from Indonesia are not allowed to enter the international market (FAO/WHO, 1999). Two factors have been identified, the first involving the low quality of organic products and the second the farmers' lack of ability to certify their products, as certification is considered expensive (Husnain *et al.*, 2005). Husnain *et al.* (2005) propose solutions to these two problems. Their first suggestion involves providing training, guidance, and services and diffusing and publicizing organic product standards. The second involves forming organic farmers' groups, which can help address problems in organic agriculture and communicate solutions.

The *second* weakness of government incentives involves the lack of subsidies for organic input and services. Even though organic farming aligns with national aims and the vision for agricultural development, the government seems reluctant to encourage farmers to back organic farming. Indeed, despite the government's good intentions in organic farming, it still pours subsidies into chemical-based agriculture, and subsidies, services, and guidance for organic and other environmentally-friendly agricultural practices are still considered lacking. The primary source of organic fertilizer is manure from livestock, but there is evidence that livestock populations have decreased, meaning that farmers consider this manure less available. Manufactured organic fertilizer is an alternative, though this and manufactured pesticides are expensive, and no government subsidy is available to buy them. According to Suryantini *et al.* (2003), upland farmers are considered risk-averse and will not be interested in making heavy investments if they are unsure of the risk. This phenomenon makes organic farming and environmentally-friendly agriculture less attractive to farmers.

The *third* weakness is related to the mechanisms involved in government and NGO assistance. The government has provided services (such as training) and guidance, but not all upland farmers can access them, and they are considered exclusive to specific groups of farmers or villages. Indeed, like many government plans, services, and guidance for organic and environmentally- friendly agriculture, they are implemented by choosing representative farmers or farmers' groups called kaders. It is how the government attempts to diffuse information to all upland farmers. However, this mechanism is not considered adequate, and information does not flow as it should. There is still inequality in terms of access to services and guidance in villages. It will be essential to pay attention to effective extension agents, kaders, and farmers' groups and ensure continuous government and NGO assistance.

In addition to the above weaknesses, other problems may stem from the farmers. Most farmers have become used to the immediate effects of using chemicals in agriculture. Organic input still brings unsatisfactory results, so farmers are unlikely to be interested in this practice. The unsatisfactory results of organic input and the lack of subsidy, combined with a lack of available services and guidance, mean that the campaign for organic and environmentally-friendly/ecology-based agriculture faces many problems.

The first starting point for any discussion on upland agricultural practices is establishing that upland farmers are considered subsistence. They have all the characteristics of small farmers, i.e., small land holdings, poverty, and poor educational background. The only thing differentiating them from other types of small farmers is that their farming practices involve steeper and more marginal areas. The second point involves the ecological value of the upland area. Hence, all discussions on the best policies and strategies toward the sustainability of upland agriculture must address both the ecological properties of the upland and the socio-economic dimension of the upland farmer. Priorities for upland agriculture must be based on agricultural practices in line with the area's conservation efforts and the farmers' limited resources. These practices should involve good land management, reducing the use of expensive chemicals, and adopting appropriate technologies commensurate with the characteristics of upland farmers.

An ideal solution is pure organic farming, involving an integrated farming system combining cultivation with livestock as a source of manure. A good experience comes from Thailand. Thailand has successfully adopted this farming strategy for upland agriculture (Suthasupa, 2004). However, livestock populations are currently considered insufficient to support the demand for manure. Organic farming with manufactured organic input has therefore become an alternative. However, this type of farming may be regarded as unsustainable because of the socio-economic situation of small farmers. In fact, despite its higher cost, manufactured organic input is also regarded as external. According to Altieri (1987), the need to buy manufactured organic input reduces cost efficiency concerning productivity. This paper considers LEIA and ecology-based agricultural/agroecological approaches appropriate for upland agriculture. Indeed, agroecology incorporates ideas involving a more environmentally and socially-sensitive agriculture (Altieri, 2002).

Incentives from the government and NGOs are the most crucial factor in affecting the adoption of sustainable upland cultivation. The government must provide a series of financial incentives by facilitating subsidized micro-credit. The case of the Grameen Bank (Yunus, 2006), which provides credit for small farming in Bangladesh, is a good example, showing that the government must focus not only on soft credit for direct upland agricultural activity but also on credit that improves a farmer's household income. Based on this observation, credit could take the form of livestock. Most upland farmers' savings are in the form of livestock (mainly cows and sheep). Providing cash to farmers could result in its problems.

Another responsibility of the government is to ensure the profitability of agricultural products from organic and other forms of environmentally-friendly farming. Government policies should ensure that the market channels for agricultural products from this type of farming are effective. Policies should also protect small farmers from a variety of economic pressures. An excellent example of the success of policies that support sustainable upland agriculture can be found in Japan, where labor, capital, and land-saving technologies have been introduced, and market places for products have been assured, bringing positive economic benefits to smallholders (Colman and Nixzon, 1994).).

The government must also provide continued assistance and monitor the system to ensure that resources reach target populations. Cooperation with research institutions and NGOs will be beneficial in designing and diffusing appropriate technology and innovations. This type of strategy has been implemented in China. Cooperation with research institutions in research and development programs has meant that upland agriculture in China improves the land and maximizes production while reducing costs (Shyan Lin, 2004).

NGOs play a significant role as government intervention is often limited to a technical and infrastructural approach. This critical role of NGOs involves strengthening local farmers or farmers' groups using an integrated approach. Even if NGOs are involved in long-term projects, they are far away from the communities they assist. They should therefore make programs more sustainable by encouraging the participation of local farmers' groups. In this sense, NGOs can also help build the networking capacity of local farmers' organizations with other farming groups, universities, and government institutions, for example. NGOs can also help diffuse new technology as an active form of advocacy and data-gathering.

Indeed, government institutions and NGOs play an essential role. When they bring in technology and innovation, it must be compatible with the local characteristics of the farmers and must consider human ecological aspects. One reason for the unsuccessful diffusion of new programs may be that technology and innovations are incompatible with the lifestyle of the farmers (Notohadiningrat, 1993). If farmers do not see the benefits of the new technology and innovations, they will choose a different way of doing things.

CONCLUSION

We conclude that the regression model can explain the linkage between the proposed predictors and the dependent variable. All predictors except the market signal were significantly associated with the extent of the adoption of sustainable agriculture. Governmental incentive becomes the significant predictor affecting the adoption of sustainable upland agriculture. Ensuring the profitability of sustainable upland agriculture by facilitating market channels, providing credit, and allocating subsidies for organic input are considered critical. Building human capital in agriculture through services is also critical in strengthening the upland farmers' confidence to adopt sustainable upland agriculture

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