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The livelihood of farmers cultivating fire-prone peatlands: Keeping the ecology and economy sustainable


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ABSTRACT

The purpose of this research was to analyze the livelihood of farmers on fire-prone peatlands and their efforts to maintain their sustainable livelihoods. The study took place in Banjarbaru, Indonesia, a fire-prone peatland area. Our 251 samples were farmers cultivating the peatland. The variables measured in this study were livelihood assets, including human assets, social assets, natural assets, physical assets, and financial assets. We employed classification and principal component analysis. The findings revealed that physical and natural assets played the most significant roles in ensuring the sustainability of farmers' livelihoods in the fire-prone peatland. Human assets also played an important role because the farmers have been cultivating peatlands for a long time, giving them the skills and knowledge for sustainable and zero-burning peatland management. Peatlands managed by farmers have a low fire potential because farmers protect their land from burning. Social and financial assets did not play significant roles because the farmers did not take advantage of the existing cooperatives and farmer groups. Increasing the role of cooperatives and farmer groups would improve people's livelihoods by increasing the contribution of social and financial assets. Sustainable peatland cultivation as a productive space has proven beneficial for preventing fires on peatlands (ecology) and livelihoods (economy).

Contribution/Originality: This study provides empirical evidence about the livelihoods of farmers on fire-prone peatlands. It shows that farmers play a large role in controlling fires and making peatlands productive to achieve better livelihoods in the future.

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1. INTRODUCTION

Peatlands contribute to biodiversity, climate control, and people's welfare. The mismanagement of peatlands has led to a decrease in environmental quality, which also means a decrease in environmental functions. One event causing a decline in environmental quality is the frequent land fires on peatlands (Elia & Yulianti, 2022). The mismanagement of peatlands, which leads to fires, includes deforestation and excessive drainage (Kiely et al., 2021; Silvianingsih, Hairiah, Suprayogo, & Van Noordwijk, 2021).

Turning shrubs into plantations on peatlands has been proven effective in reducing fires by around 40-55% (Horton, Lehtinen, & Kumm, 2022). Farmers have often been blamed for peat burning, yet the peat burning farmers do is more controllable than the fires that occur in unmanaged shrubs on peatlands. Unmanaged peatlands with shrubs as the ground cover tend to be left unattended, making the area prone to fires (Arisanty, Rajiani, Hastuti, Putro, & Abbas, 2022). Farmers who cultivate peatlands work to maintain economic and ecological sustainability, so the peatland cultivated by farmers has a lower probability of uncontrolled fires (Arisanty et al., 2022; Elia & Yulianti, 2022).

Peatlands have good potential for agriculture. Shallow peatlands can be planted with crops, including vegetables (Surahman, Shivakoti, & Soni, 2017). Crops and horticultural plants were planted on peatlands from the 1970s up to the 1990s. Since the 2000s, plantations have developed rapidly on peatlands. Data show that crops and horticultural plants cover 0.5-0.8 million hectares of peatlands, while palm oil plantations cover 2.5-3.0 million hectares (Hairani & Noor, 2020).

Frequent land fires damage plants and agricultural land (Kiely et al., 2021). The ash that accumulates after peatland fires increase soil pH, organic matter, humic acid content, hydrophobicity, available N, and available K. However, its availability is only temporary because it is quickly reduced and washed away, which results in long-term land degradation (Agus et al., 2019; Arisanty, Jędrasiak, Rajiani, & Grabara, 2020).

Peatland degradation affects the direct users of the land and the surrounding community as a whole (Rawlins & Morris, 2010). Peatland degradation reduces the quality of agricultural land, which affects the livelihood of peatland farmers (Arisanty et al., 2020; Ulya, Waluyo, Nurlia, Rahmat, & Martin, 2021; Winarno, Rohadi, Herawati, Rahmat, & Suwarno, 2020). Peatland degradation may cause people to lose their livelihoods (Thornton et al., 2020). Environmental changes and the effects of such changes on people's livelihoods are one of the obstacles people have to deal with (Nasrnia & Ashktorab, 2021). The sustainable livelihood assessment and framework can help to analyze the effects of such environmental changes on livelihoods (Hidayat, Rajiani, & Arisanty, 2022).

Livelihood sustainability has become crucial in disaster management and mitigation because people's livelihoods often become vulnerable after a disaster (Yang, Yang, Min, & Liu, 2022). This vulnerability also occurs after fires, and suitable countermeasures require the systematic integration of multidimensional variables. The livelihood vulnerability index (LVI) can be used to measure the threat of fire disasters in physical and social environments (Baijnath-Rodino, Kumar, Rivera, Tran, & Banerjee, 2021). The sustainable livelihood framework presents the principal factors affecting people's livelihoods and the relationship between those factors. This framework is suitable for assessing development and contributes to sustainable livelihoods (Sheets, 2001).

Strategies for sustainable livelihood refer to the process of developing certain activities or skills supported by various social aspects and assets to survive or improve living standards, such as processing various resources or livelihood assets, using possessed capabilities, and taking advantage of opportunities (Carney, 1998; Masri & Prasodjo, 2021). The elements of a livelihood strategy are assets, capabilities, and activities—the three are inseparable (Chambers & Conway, 1992). These three elements show the dynamic relationship underlying livelihood strategies.

The choice of livelihood strategies is based on the assets one has and the situational context (Ferdiani, Baiquni, & Purwohandoyo, 2016). Livelihood assets are at the center of the livelihood framework in the context of vulnerability. Livelihoods assets consist of human assets (e.g., skills, knowledge, and health), social assets (e.g., networks, membership of groups, relationships of trust, access to institutions), natural assets (e.g., land, water, wildlife, and environmental resources), physical assets (transportation, shelter, water supply, and energy supply), and financial assets (e.g., savings, credit, remittances, and pensions) (Arram, 2021; Sheets, 2001).

Peatland fires always occur during the dry season in South Kalimantan, and the dry season in Banjarbaru is rather severe (Arisanty et al., 2020; Arisanty et al., 2021; Arisanty et al., 2021). The peatland fires in Banjarbaru occur in uncultivated peatlands covered with shrubs. The fires sometimes grow too big and reach the adjacent agricultural lands—which indeed affects the livelihood of the farmers (Arisanty et al., 2022).

Since 2016, peatland restoration has taken place in several areas of Indonesia. The initiative was started by *Badan Restorasi Gambut dan Mangrove Republik Indonesia (BRGM)* or the Peatland and Mangrove Restoration Agency of the Republic of Indonesia. Kalimantan Selatan is one of the areas undergoing peatland restoration (Yuwati et al., 2021). Peatland restoration programs run by BRGM consist of rewetting, revegetation, and revitalization of livelihood sources (BRGM, 2022; Harrison et al., 2020). The revitalization stage of the restoration program is crucial because the aim of revitalization is to improve people's wealth on fire-prone peatlands; one of the efforts to achieve this is through agricultural activities (BRGM, 2022).

Some areas of fire management priority in South Kalimantan include *Kesatuan Hidrologis Gambut (KHG)* or the Peat Hydrological Unit of Sungai Balangan-Sungai Batang Alai, *KHG* Sungai Barito-Sungai Alalak, *KHG* Sungai Barito-Sungai Tapin, *KHG* Sungai Utar-Sungai Serapat, and *KHG* Sungai Maluka-Sungai Martapura. Banjarbaru is one of the restoration areas in *KHG* Sungai Maluka-Sungai Martapura; the restoration program was established in 2022 and will commence in 2023 (TRGD, 2022). Banjarbaru is vital because Syamsudin Noor International Airport is

located in Banjarbaru, and peatland fires have wide-reaching effects on people's livelihoods (Arisanty et al., 2022; Arisanty et al., 2021; Arisanty et al., 2022).

Peatlands in Banjarbaru are planted with crops and horticultural plants. Farmers mostly grow local rice, with a total rice field area of 1,834 ha and a productivity of 3.68 tons/ha in 2019 (Wahyuni, Rosni, & Yulianti, 2021). The peatland fires frequently occurring in Banjarbaru affect the livelihood sustainability of the local farmers. Thus, the present study aims to analyze farmers' livelihoods on fire-prone peatlands and their efforts to maintain their sustainable livelihoods.

2. MATERIALS AND METHODS

Our study was conducted on fire-prone peatlands in Banjarbaru, South Kalimantan, Indonesia. The area covers the villages of Landasan Ulin Timur and Syamsudin Noor (Arisanty, Adyatma, Muhaimin, & Nursaputra, 2019; Arisanty et al., 2020; Arisanty et al., 2021; Arisanty et al., 2021; Arisanty et al., 2022). The study site is presented in Figure 1.

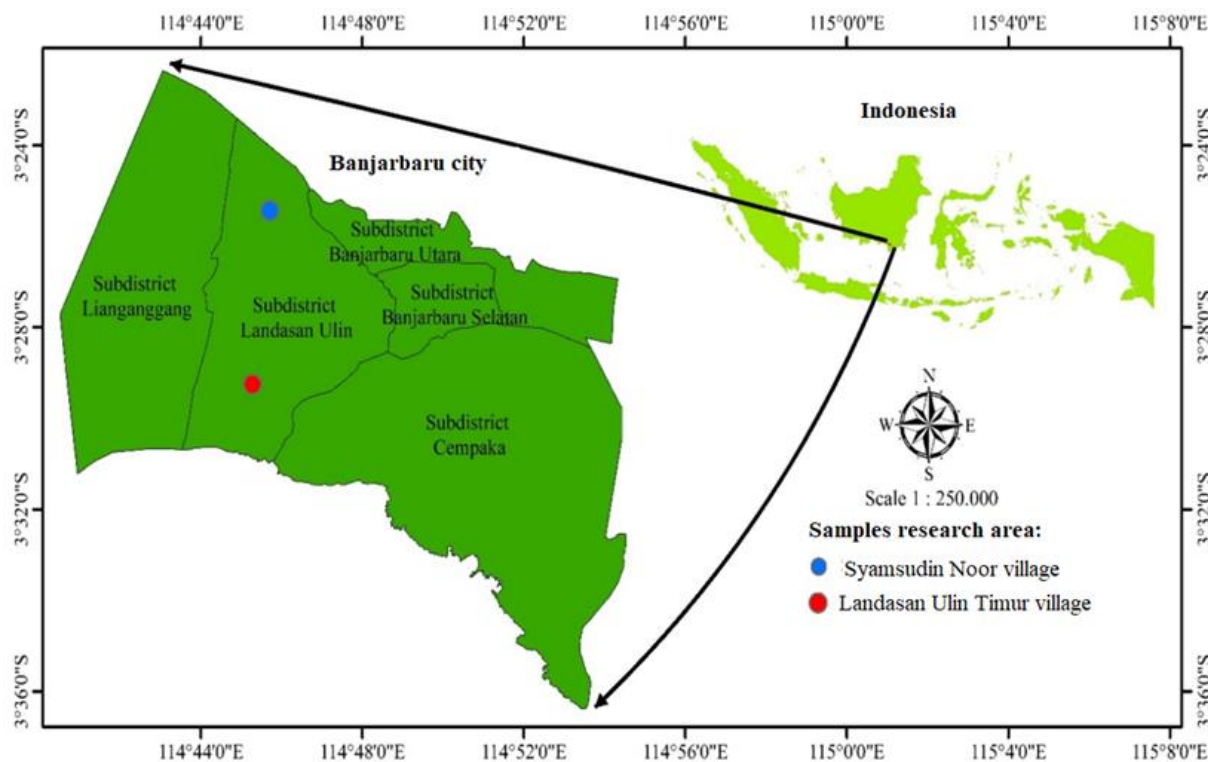


Figure 1. Map of the study sites.

Fires in this area affect farmers as the agricultural land also experiences fires. Our sample included 251 farmers. Data were collected through observations and questionnaires. The research variables were based on the pentagon of assets (Sheets, 2001) consisting of natural (NA), social (SA), human (HA), physical (PA), and financial (FA) assets. Based on these five assets, we developed a 47-item questionnaire to elicit data from the respondents: 13 items on human assets, 7 items on social assets, 6 items on natural assets, 15 items on physical assets, and 6 items on financial assets. Table 1 presents a complete overview of the livelihood asset variables.

The livelihood assessment was carried out by assigning a score to each indicator. Next, the score of all indicators was calculated based on the response of each respondent. Each item was given a score, with 4 as the highest and 1 as the lowest. Then, we added up the score each respondent gave for each variable. Each variable was classified into one of three categories based on the total score: low, moderate, or high. The classification represents the condition of the local people on each variable and their livelihood. We proceeded with the sustainable livelihood analysis by grouping the score of each respondent on each variable and calculating the percentage for each variable. Table 2 illustrates the classification of each variable.

Principal component analysis (PCA) was used to identify the factors with the most significant effect on the livelihood of the farmers in the fire-prone peatlands. PCA is an analysis technique for reducing big data with many variables and observations on each variable (Kherif & Latypova, 2020). We employed SPSS 22 to conduct the PCA.

Table 1. Livelihood asset variables.

Variable	Statements	
Human assets (HA)	Most of my family members have graduated from senior high school and higher education (University).	
	The number of working-age family members who have finished school and have an income.	
	I have been a farmer for a long time.	
	I have a side job in addition to my primary job as a farmer.	
	I have sufficient knowledge of farming.	
	I have the skills to run a business related to agriculture.	
	I have the skills to run a business not related to agriculture.	
	I have received training in agricultural management.	
	I am willing to undergo more training in agricultural management.	
	I have specific health issues that may hinder my activities.	
	I know how to get assistance from the government or local organizations to support my livelihood.	
Mention the types of assistance you receive as a farmer.		
Social assets (SA)	I join local organizations to increase my assets.	
	The community I live in always considers my suggestions.	
	Mention the types of local organizations (Farmer groups) you are a member of.	
	I actively participate in local organizations (Farmer groups).	
	I am on good terms with government organizations responsible for assistance during difficult times.	
	I am on good terms with service providers for farmers (The ones who supply fertilizers, pesticides, and others).	
	I usually participate in programs or activities held by the government or non-government organizations (NGOs).	
Natural assets (NA)	There is abundant land for agriculture.	
	Peatlands are beneficial to farmers.	
	Mention the agricultural productivity of peatlands during the rainy season.	
	Mention the agricultural productivity of peatlands during the dry season.	
	The available land can be used to plant any plants.	
Land productivity has been decreasing recently.		
Physical assets (PA)	Land ownership	
	Ownership of assets: <ul style="list-style-type: none"> • Houses • Cars • Motorcycles or tricycles • Bikes • Televisions • Handphones • Refrigerators • AC • Fans • Computers 	
	Easy access to agricultural land.	
	All farmers have full access to manage the available land or areas.	
	The agricultural land owned is close to the house.	
	I have many farming tools.	
	Financial assets (FA)	The money I earn from farming is enough for my daily needs.
		I have received financial assistance from the government to increase my assets.
I have a salary/wage, savings, debts, receivables, inheritance, and gifts (BLT/BASIS/LSM).		
I receive social assistance from the government.		
I have a family inheritance.		
I take advantage of the cooperatives.		

Table 2. Classification of variables based on scores.

Variable	Categories		
	Low	Moderate	High
Human assets	13-25	26-38	39-52
Social assets	7-13	14-20	21-28
Natural assets	6-11	12-17	18-24
Physical assets	15-29	30-44	45-60
Financial assets	6-11	12-17	18-24
Livelihood	47-93	94-140	141-188

3. RESULTS AND DISCUSSION

3.1. The Livelihood of Farmers Cultivating Fire-Prone Peatlands

The livelihood index is the result of the accumulation of the values of human assets, social assets, natural assets, physical assets, and financial assets. The livelihood of farmers cultivating fire-prone peatlands is presented in [Table 3](#).

Table 3. Livelihood of farmers cultivating fire-prone peatlands.

Assets	Categories		
	Low	Moderate	High
	Percentage (%)		
Human assets	23.2	71.7	5.1
Social assets	75.3	23.5	1.2
Natural assets	7.2	72.1	20.7
Physical assets	2.4	52.2	45.4
Financial assets	94.4	5.3	0.3
Livelihood	7.2	92.8	0

Human assets include the levels of education, knowledge, and skills farmers have in cultivating their land. Human assets are indispensable in managing other livelihood assets. For the majority, human assets are in the moderate category, with 71.7% percent. Although the farmers had a low educational level, only elementary school, they had good knowledge of farming. They had been cultivating the peatlands for 6-10 years. They understood the problems in the peatlands and how to solve them. They had received training from extension officials on agricultural land management, and they received assistance in the form of fertilizers, seeds, and farming tools. The data in [Table 3](#) confirm that human assets can support the livelihood of farmers cultivating peatlands.

Social assets include social networks farmers join, either formally or informally. These social networks support the sustainable livelihoods of farmers on fire-prone peatlands. For most, social assets are in the low category, with 75.3% of farmers having a low level of social assets because they had not joined farmer groups, cooperatives, or other organizations. The farmers did not participate actively in the activities of farmer groups, government organizations, or non-government organizations. Social assets are important because they help farmers exchange knowledge, experience, and ideas about managing peatlands. As such, our respondents were found to have low social assets. These farmers need to improve their participation in social organizations to improve their livelihoods.

Natural assets include land ownership and the existence of peatlands that are beneficial to farmers. The agricultural peatlands farmers own support their livelihood sustainability. Natural assets support farmers' livelihoods. The farmers owned large peatland farms (> 2 ha) to support their livelihood, although they confirmed that fires had decreased their land's productivity. They could plant various short-age horticultural plants such as chilis, tomatoes, mustard greens, sweet potatoes, cassava, bananas, and oranges ([Figure 2](#)). The peatland planted with various crops and horticultural plants was able to support the farmers' livelihood. The farmers plant throughout the year so they have income all year round.

The farmers were able to solve the issue of peatland fires—they managed to keep their agricultural land free from fires and prevent the fires from spreading widely. The farmers used the existing drilled wells to wet agricultural land and extinguish fires when they occurred ([Arisanty et al., 2022](#)). Farming on the fire-prone peatlands actually reduces the potential for the land to burn because farmers take good care of the land to prevent it from catching fire. In addition, the government has provided counseling to farmers about how to prepare land without burning. Fire-prone areas on peatlands are those that are not managed properly and are overgrown with shrubs ([Arisanty et al., 2022; Arisanty et al., 2022](#)).

Physical assets refer to the facilities the farmers have to support their livelihood sustainability. Physical assets include property, land, and facilities that support their efforts to cultivate the fire-prone peatlands. [Table 3](#) illustrates the farmers' physical assets. Overall, their physical assets belonged to the moderate category, as much as 52.2%. The farmers had sufficient facilities, including houses, agricultural land, vehicles, and farming tools, to support their work. The farmers owned the agricultural land, so the income from farming activities was their primary income. The close distance and easy access to the agricultural land from their homes helped them cultivate their land well; this had a significant impact on the livelihood of the farmers.



Figure 2. Peatlands planted with horticultural plants.

Financial assets include the income generated from agricultural and other activities, including inheritance and social assistance from the government. Table 3 shows the financial assets of farmers that contribute to their livelihoods. Their financial assets are in the low category. The farmers stated that their income from agriculture was sufficient for their daily lives. However, they did not receive social assistance from the government to improve their livelihoods. Farmers also stated that they had no inheritance or other income aside from agricultural activities. Farmers did not take advantage of cooperatives in terms of savings and loans for agricultural activities. Thus, agricultural activities were farmers' main job and main source of income. It would be advisable for them to take advantage of cooperatives to increase their financial assets, especially by adding assets for agricultural activities.

Table 3 shows that the overall livelihood level of the farmers was in the moderate category (92.8%), which means that the farmers' assets could support their livelihoods. In other words, although their agricultural land was in a fire-prone peatland area, it could support them. The farmers were used to cultivating the area and understood what to do. They were skillful farmers who practiced various mitigation efforts to prevent fires from damaging their land.

Various assets help support sustainable livelihoods on the fire-prone peatland, in particular the physical and natural assets, as elaborated in Figure 3.

Table 4. Sustainable livelihood approach (SLA) level of peatland farmers.

Aspect of SLA	Value (%)
Human assets	61
Social assets	42
Natural assets	71
Physical assets	81
Financial assets	36

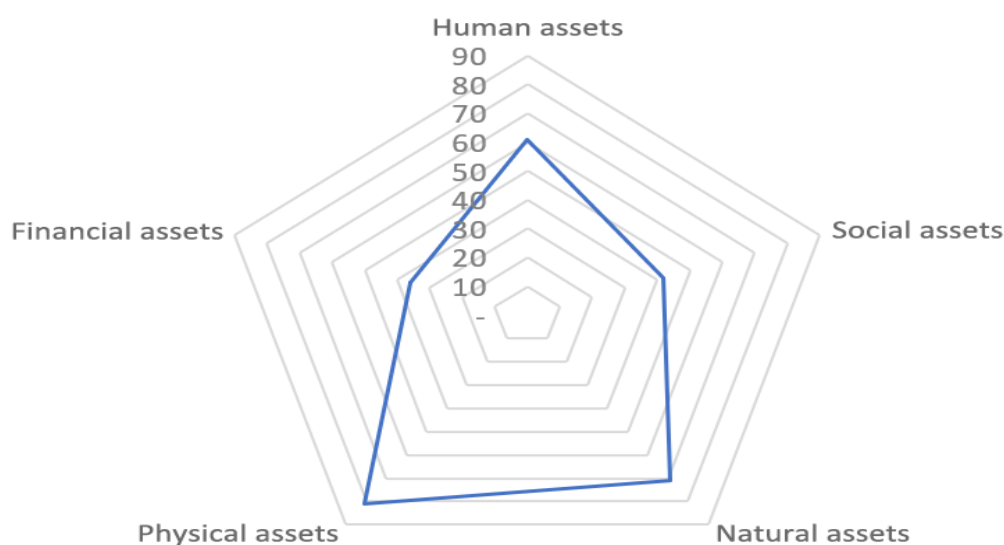


Figure 3. Level of sustainable livelihood approach (SLA).

Table 4 and Figure 3 describe the livelihood sustainability of farmers cultivating peatlands. Physical and natural assets play a very significant role in farmers' sustainable livelihoods. Ownership of a large land area (> 2 ha),

availability of agricultural tools, and easy access and close distance to the agricultural land make it easy for farmers to manage the land to improve their lives.

The factors with the most significant effects on the livelihoods of the farmers were identified using principal component analysis (PCA). The factors affecting sustainable livelihoods are human assets, social assets, natural assets, physical assets, and financial assets. All assets have a correlation value > 0.5 , so all assets were included in the calculation (Table 5).

Table 6 illustrates the number of components formed. The variance column has 2 components formed: component 1 with a value of 31.140 and component 2 with a value of 27.091. The two components determine the factors with the most significant effects on the livelihood of the farmers. The effect of components 1 and 2 on the livelihood of farmers is 58.232 or 58.232%. The variables formed as factor variables include human, social, natural, physical, and financial assets.

Table 5. Anti-image matrices.

Variables		HA	SA	NA	PA	FA
Anti-image covariance	HA	0.777	-0.342	-0.106	-0.050	-0.048
	SA	-0.342	0.786	0.009	-0.026	-0.093
	NA	-0.106	0.009	0.870	-0.211	0.216
	PA	-0.050	-0.026	-0.211	0.929	0.000
	FA	-0.048	-0.093	0.216	0.000	0.920
Anti-image correlation	HA	0.528 ^a	-0.438	-0.128	-0.059	-0.057
	SA	-0.438	0.527 ^a	0.011	-0.030	-0.110
	NA	-0.128	0.011	0.517 ^a	-0.234	0.241
	PA	-0.059	-0.030	-0.234	0.584 ^a	0.000
	FA	-0.057	-0.110	0.241	0.000	0.533 ^a

Note: a. Measures of sampling adequacy (MSA).

Table 6. Total variance explained.

Component	Initial eigenvalues			Extraction sums of squared loadings		
	Total	% of variance	Cumulative %	Total	% of variance	Cumulative %
1	1.557	31.140	31.140	1.557	31.140	31.140
2	1.355	27.091	58.232	1.355	27.091	58.232
3	0.884	17.681	75.913	0.884	17.681	75.913
4	0.667	13.341	89.254	0.667	13.341	89.254
5	0.537	10.746	100.000	0.537	10.746	100.000

Note: Extraction method: principal component analysis.

Table 7 describes the variables that affect the livelihood level. The first factors that influence the livelihood level are human and social assets, with correlation values of 0.805 and 0.753, respectively. The second factors are natural, physical, and financial assets, with correlation values of 0.702, 0.470, and 0.703, respectively.

Table 7. Component matrix^a.

Variables	Component	
	1	2
HA	0.805	0.175
SA	0.753	0.340
NA	0.388	0.702
PA	0.423	0.470
FA	0.106	0.703

Note: Extraction method: principal component analysis.
a. 2 components extracted.

3.2. Efforts to Maintain the Sustainable Livelihood of Farmers Cultivating Fire-Prone Peatlands

Since the farmers had a moderate livelihood level, it should be easy for them to make various efforts to improve their livelihood, including improving their human, social, and financial assets and maintaining and improving their physical and natural assets. Human assets can be improved through skill improvement in cultivating the peatland, such as by participating in extension activities. The farmers can also increase their expertise in combining fertilizers, for example, by utilizing various types of manure widely available in the environment where they live. The farmers can also innovate in their agriculture activities, for instance by planting according to the season and diversifying plant species.

Community livelihoods derived from cultivating the fire-prone peatlands are determined by five factors: human assets, social assets, natural assets, physical assets, and financial assets. Physical and natural assets play the most significant roles in the livelihoods of the farmers cultivating the peatlands. Physical assets are in the medium-high category; however, they can be optimized by equipping farmers with various high-tech agricultural equipment. In addition, less productive land overgrown with shrubs can be converted into productive agricultural land. Farmers

who manage the previously less productive land can increase their income and prevent the fires that often occur in these areas.

The farmers have large areas of land and plant various crops to make the land productive. In addition, they also have a relatively complete set of farming tools that make it easy for them to manage their land. Adapting the utilization of agricultural land by adjusting plant varieties, water and fertilizer management, agricultural financing, and agrotechnical support can be used to deal with livelihood risks (Kuang, Jin, He, Ning, & Wan, 2020). Innovative agricultural technology is one key to success in agriculture on peatlands. In addition, an understanding of land characteristics and water management is essential (Sulaeman, 2019).

Social assets can be increased by optimizing the role of farmer groups. Farmer groups can provide seeds and fertilizer and initiate knowledge-sharing sessions about managing peatlands. The farmers also need to take advantage of the existing cooperatives to increase the role of associations and farmer groups, which in turn will increase social assets in agriculture.

Financial assets can also be increased with the help of cooperatives. Cooperatives can offer savings and loans to increase capital for farming. Many of the farmers lacked capital, so the role of cooperatives is very important. The farmers can also use cooperatives to sell their agricultural products to buyers.

Social and financial assets played a minor role in the farmers' livelihoods. The farmers did not take advantage of cooperatives to increase their capital through the loans offered. Such loans would help the farmers improve their agricultural activities to increase their income (Mariyono, 2019). Cooperatives can also help the farmers to sell their agricultural products. Social networks are highly important in supporting people's livelihoods (De Bruin, Dengerink, & van Vliet, 2021). Cooperatives can function as social networks that can increase farmers' livelihoods because cooperatives can provide the necessary capital and network to market agricultural products.

Social assets must be managed better through farmer groups. Farmer groups can be a way to share knowledge among farmers and solve the fire issue. Members of a farmer group can work together to tackle fires on their land. Although the group *Masyarakat Peduli Api (MPA)* or Fire Care Community helps manage fires, its members are not farmers. *MPA* consists of community members who voluntarily control fires; they have been trained and can be empowered to assist in forest and land fire control activities. Its members are volunteers organized by *Badan Penanggulangan Bencana Daerah (BPBD)*, the National Agency for Disaster Countermeasures, or the community's initiative (Arisanty et al., 2021). Farmer groups may cooperate with *MPA* to prevent and control fires on peatlands.

Natural assets can be increased by making the best use of land to produce all year round. Agricultural activities using the innovative *surjan* system can improve livelihood sustainability. Peatlands in swamps are inundated during the rainy season, so not all plants can be grown in such areas. The inundated land must be raised by constructing walls or mounds, so the land becomes high and dry. This system is more economically profitable because the land can be planted with various types of plants, including both seasonal and vegetable crops. *Surjan* is the system implemented in peatlands cultivated as agricultural land, which are usually inundated in the rainy season and prone to fire in the dry season. The *surjan* system is beneficial because it can be implemented all year round to grow various crops. In this system, farmers plant annual crops on dry land, and flooded areas are planted with rice and fish (Sulaeman, 2019). Various plants can be grown, such as rice, oranges, vegetables, and others, in a way that is integrated with other activities, such as fish ponds (Kurnain, Mahbub, Septiana, Makalew, & Murjani, 2022). This system can also be implemented by planting rice in paddy fields and oranges on dry land. In addition, the system can be combined with chicken and duck farming and fisheries. Good land management can improve the community's economy because harvests occur throughout the year, which increases the farmers' livelihood sustainability. This can improve the livelihood of farmers cultivating peatlands because their land becomes productive all year round.

The farmers cultivating peatlands had quite good human assets. They commonly have good knowledge and skills for managing agricultural activities on peatlands because they have been doing so for more than 10 years. The skills and knowledge farmers have on peatland cultivation and management significantly impact the sustainability of peatlands (Samsudin, Puspitaloka, Rahman, Chandran, & Baral, 2020). The agricultural land on the peatlands has been cultivated for a long time and has become the primary source of income for the farmers, meaning that sustainability has been achieved. The farmers work on their land full-time because they have no other skills and have low educational backgrounds (elementary and junior high schools). Their skills in managing the peatlands to become productive areas have turned the peatlands into something valuable. The farmers can provide their children with a better education using the agricultural income. However, regeneration has become a major problem because their grown-up children prefer to work in other sectors. Agriculture is seen as an old-man activity, meaning only the elderly still farm. There is a need to create agricultural innovations to attract the young generation to farming.

By utilizing the peatlands as productive land, the farmers help prevent fires. The farmers ensure that no fires attack their land and have prepared a mitigation system, using drilled wells and irrigation, to prevent fires from damaging their land (Arisanty et al., 2022). Uncultivated land is overgrown with shrubs and is usually left unattended so it has a higher risk of fires (Arisanty et al., 2021). The farmers' agricultural activities offer two benefits: livelihoods for the people (the economy) and a reduction in the risk of fires (the ecology).

4. CONCLUSION

Physical and natural assets significantly affect the livelihood sustainability of farmers cultivating fire-prone peatlands. Ownership of large areas of peatland, adequate agricultural equipment, and easy access to peatland farms mean that peatlands play a significant role in farmers' livelihoods. Farmers' knowledge and skills in managing peatlands also significantly impact the sustainability of community livelihoods. Nevertheless, farmers do not take

sufficient advantage of the existing cooperatives and farmer groups as social networks and a way to increase their capital.

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