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# MULTIFUNCTIONALITY OF INTEGRATED PLANTATION POLYCULTURE FARMING IN TASIKMALAYA REGENCY, WEST JAVA, INDONESIA

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## ABSTRACT
Resilience, independence and sovereignty have historically been successfully realized by local communities through diversification. In fact, diversification has been institutionalized in farming communities in dryland agroecosystems. This research uses a survey method to gather data from 250 farmers in Tasikmalaya Regency, West Java, Indonesia, who carry out integrated plantation polyculture farming (IPPF). The main variables of the multifunctional IPPF are economic, social, cultural and environmental functions as well as the welfare of the farmers involved in the IPPF. Primary data were collected through interviews using questionnaires and secondary data were obtained from various related parties. Primary data were tabulated and analyzed descriptively and quantitatively using Farmer Household Income Exchange Rate (FHIER) analysis. In general, the farmers stated that IPPF contributed to the economy of farmers and the community, has a high social function, and also has an environmental function. On average, IPPF farmers' families in Tasikmalaya Regency are categorized as prosperous families (FHIER > 1). Farmer households spend more income to meet consumption needs (FHIER = 1.66) compared to IPPF production costs (FHIER = 22.94), and non-food consumption (FHIER = 4.88) was greater than food consumption (FHIER = 4.48).

**Contribution/Originality:** This research contributes to agricultural development because the multifunctional study of integrated plantation polyculture farming (IPPF) provides an understanding that efforts to increase production for the welfare of farmers can be carried out while maintaining local knowledge (culture) and can maintain and improve environmental quality to avoid various environmental risks such as floods and landslides.

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## 1. INTRODUCTION

Historically, food security, independence and sovereignty have been successfully realized by local communities through a diversification approach. On a macro level, Japan, India and Turkey in the contemporary era have succeeded in realizing food security, sovereignty and self-sufficiency through food diversification and crop diversification

(Archana & Khyrunnisa, 2017; Irem & Talat, 2001; Sheereen & Shazia, 2016; Uehara, 2012; Wahyu & Iwan, 2017). Food security, independence and sovereignty are some of the sustainable development goals (SDGs) to be realized.

In fact, in Indonesia, food and plant diversification is institutionalized for farmers in dryland agroecosystem zones. The diversity of cropping patterns in one year and the diversity of plants in one season cultivated on one plot of land have led to adaptation and mitigation strategies applied by farmers in dryland agroecosystem zones. Food crops, fruits, perennials and medicinal plants are commodities that are commonly grown in dry land areas in Java, Sumatra, Sulawesi, Maluku and Papua (Balitbangtan, 2014; Darmawan, Akira, Tosiyuki, & Tugiyuki, 2002; FAO, 2017; Roosganda, 2011).

Statistically, the Central Bureau of Statistics (2017) noted that 88% of agricultural land in Indonesia are drylands. Quantitatively, the Agricultural Development Research Center of the Indonesian Ministry of Agriculture reports that in Indonesia there are around 80 million hectares of drylands that have the potential for food development. This confirms that drylands have enormous potential to support the realization of food security, independence and sovereignty. However, the huge potential of drylands has not been widely used. In fact, drylands are still marginalized and neglected because they are poorly understood in terms of ecosystems, sociosystems and geosystems. Year-on-year, the diversity of food crops in dryland agroecosystem zones is being reduced by uniformity. Ironically, drylands have long been living spaces and the foundation of life for some marginal poor people in rural areas (Maman, 2013).

In contrast to indigenous people and traditional rural communities who possess a great deal of wisdom, the contemporary poor who exist in marginal dryland agroecosystem zones have weak capabilities in terms of capital, technology adoption, seasonal farming and farming culture, and this has had a negative impact on the environment. All four of these aspects are interrelated determinants and have a sustainable negative impact on the land and farmers' livelihoods. In fact, it has created unproductive critical lands (Herman & Handewi, 2004). This has implications not only for the reduction of productivity and farm income, but can also trigger migration and low ratings for generations of farmers.

Agricultural modernization and rural industrialization have been implemented since 1970, but they have been biased towards wetlands, especially rice fields. Meanwhile, drylands, which are plentiful and have very diverse conditions, still depend on the rainy season. In fact, with climate conditions that are always changing, the efficiency and effectiveness of the application of farming technology and dryland management are increasingly facing many obstacles. Ironically, the sustainability of land management is strongly influenced by many resources, including land, water, human actions, technology and the economy of the surrounding area. Strictly speaking, business sustainability and dryland management are influenced by land access and physical (ecosystem), social, economic and technological environments controlled by local residents (sociosystem) as well as geological conditions (geosystem) and geographical location (Abdoellah, 2017; Mufid, 2014; Soeryo, Fredian, & Prastowo, 2005).

Climate change multiplies the opportunities and challenges for dryland farmers in managing their land and businesses. Sutrisno, Muhrizal, and Effendi (2010) stated that in facing climate change, agricultural sector actors and managers must develop adaptive and anticipatory agriculture. Climate change should be seen as an opportunity to increase productivity and business innovation. Dryland agriculture must be created and innovated in order to increase production and contributions. Strictly speaking, dry land agriculture must have an adaptive and anticipatory strategy in order to mitigate the negative impacts of climate change.

Adaptive and anticipatory farming on drylands can be done by integrating various approaches and technologies, both from local sources (local knowledge) and those from the global environment (global innovation). One approach that is in line with this thinking is an integrated farming system (Abdurahman, Ismail, & Sutono, 1997; Coen, Bertus, & Ann, 1992). IPPF is a form of integrated farming system and is a model that not only pays attention to the production function, but many functions (multifunctionality). Biswas (2010) explains that mixed farming systems or integrated farming provide better benefits in terms of time, money, resources and family labor. In addition, it also provides a more open space for farming families to find work throughout the year. This is a condition that ensures farming families have a better income and standard of living than small scale businesses. Ecologically, planting annual crops on land with high slopes makes this possible and ensures land and water conservation. The use of the vegetative method reduces the rate of erosion and landslides (Suwarto & Sapja, 2012).

Socio-spatially, dryland farmers in the southern part of West Java have implemented various integrated farming approaches, including IPPF. One of the pilot areas for the implementation of IPPF in the southern West Java region is Tasikmalaya Regency. The uniqueness of IPPF in Tasikmalaya Regency is that it was built through internalization of local approaches (localism) with the institutionalization of innovations introduced from outside (social engineering). This study aims to describe and analyze the economic, socio-cultural and ecological functions, as well as study the welfare of farmers involved in IPPF in Tasikmalaya Regency.

## 2. METHODS

This research has a positivist paradigm which was designed quantitatively by using a survey method and was carried out in Tasikmalaya Regency, West Java Province, Indonesia. The survey was conducted from February to November 2018 on 250 farmers who are involved in integrated plantation polyculture farming (IPPF). The location was determined purposively, and the determination of the sample of farmers was carried out using Slovin's formula.

The main variable in this study is the IPPF multifunction, which includes economic functions (producing agricultural products, sources of income, employment providers), socio-cultural functions (social interaction, IPPF experience, origin of IPPF knowledge) and environmental functions (soil and water conservation, pollution control, waste recycling).

Primary data were collected from farmers through structured interviews using a questionnaire.

Secondary data were obtained from various related parties through observation techniques, literature studies (desk studies) and documentation studies. The primary data were then tabulated and analyzed descriptively and quantitatively using FHIER analysis with the formula according to Vibilia, Charles, and Ellen (2019) as follows:

$$FHIER = \frac{Y}{E}$$

FHIER = Farmers' Household Income Exchange Rate.
Y = Farmer's Household Income.
E = Farmer's Household Expenditure.
From the FHIER values, we can determine the following:

- A FHIER value of < 1 means that the level of a farmer's welfare is low or that a farmer's household does not yet have the ability to allocate income to different expenditures (example: food and clothing expenditure and food and education expenditure), or the purchasing power of farmers is still lacking.
- A FHIER value of > 1 means that the farming household is prosperous or the household has the ability to allocate income to different expenditures.

## 3. RESULTS AND DISCUSSION

Farmers who are the main actors in integrated plantation polyculture farming have the following personal and farming characteristics: almost 91% of them are of a productive age (15–64 years), more than half of them (51.60%) have 3–5 dependent family members, and 45.60% of them only have 0–2 dependents. Almost all farmers are married (96.80%), while the rest (1.60%) are single or widowed. In general, farmers in the dryland agroecosystem zones are old and have a basic (53.60%), medium (44.00%) or high (1.64%) education. Being a farmer is the primary job of most farmers. Quantitatively, the experience of farmers in implementing IPPF varies, ranging from 1–50 years. Farmers who are experienced in implementing IPPF for one year does not mean they have just implemented it. In fact, the commodity a farmer cultivates has been in production for a long time because it has been inherited. In general, the average farmer owns an IPPF area of 0.62 ha.

The management of dryland farming systems is strongly influenced by various ecosystem elements, such as land conditions, water, plants, livestock, and soil nutrients. Water is a major limiting factor because its availability is highly dependent on rain. Therefore, IPPF management in dryland areas requires a special and adaptive strategy. As ecosystems, drylands have various functions—conservation (including environmental services), economic, and socio-cultural. IPPF in drylands is one model of sustainable agricultural development. Coen et al. (1992) called it low external input sustainable agriculture (LEISA). This farming model not only pays attention to the diversity of the types of commodities being cultivated, but also the adaptive, protective and anticipatory functions. What is cultivated in an integrated manner in drylands has a clear function.

The results of in-depth interviews with farmer leader A in Cibalong District revealed: *"'Huma' rice (upland rice), corn, vegetables and beans are cultivated at the beginning of the rainy season with the aim of meeting daily food needs. Sweet potatoes, cassava, turmeric, galangal and other medicinal plants are cultivated after the seasonal crops with the main aim of meeting farming costs, especially land preparation costs for the planting season. Meanwhile, the results of livestock and plantation crops are intended to fulfil secondary needs, especially costs for celebrations, holidays, children's schools and households. Perennials (especially wood) are intended to fulfil tertiary needs, including building houses, buying household appliances and even buying motor vehicles. The types of plants which are intercropped and/or rotated also influence aspects of adaptation and anticipation"*.

Undang, Nono, and Iwa (2010) explained that agricultural cultivation activities in drylands have various functions, such as producing agricultural products, providing employment, controlling floods, protecting water sources, maintaining the sustainability of groundwater supplies, filtering $CO_2$ and/or air purifiers, maintaining natural beauty, protection of biodiversity, air conditioning, recycling of organic matter, and so on. The following are aspects related to the multifunctionality of IPPF in the upland agroecosystem zones from economic, socio-cultural, and environmental aspects.

### *3.1. Economic Function*

IPPF is a type of farming that produces more than one type of agricultural crop commodity. It's not only a variety of crops, but also a variety of livestock and even fish. The IPPF cropping pattern cultivated by farmers in the dryland agroecosystem zone of Tasikmalaya Regency is a combination of woody plants, plantations, horticulture, food and poultry, large ruminants and small ruminants. Based on the diversity, farmers cultivate their land with three types of crop commodities which are integrated with sheep and cattle business. However, there are also farmers who cultivate up to eight commodities and one type of livestock.

The diversity of these plants forms a varied cropping pattern. Most of the farmers apply the albasiah–durian–cardamom–coconut–pepper–mango–jackfruit–banana cropping pattern that is integrated with goats. However, there are also farmers who cultivate eight types of crop commodities that are integrated with two types of livestock with the following pattern: albasiah–clove–cocoa–coconut–coffee–pepper–paddy–bananas integrated with sheep and cattle. In fact, there are also farmers who combine nine crop commodities with one type of livestock, with a cropping pattern of albasiah–clove–ginger–cardamom–rubber–turmeric–pepper–galangal–bananas that is integrated with cattle.

All of these IPPF patterns and combinations clearly provide direct and indirect benefits to farmers and rural communities in general. Based on the identification results, it is known that IPPF produces various agricultural, plantation, livestock and forestry products. First, it produces various types of wood and their by-products from hard plants, such as albasiah, mahogany, teak and manglid; second, it produces various products from plantation crops in the form of cocoa, coffee, rubber, cloves, pepper, coconut and nutmeg; third, it produces various products from horticultural plants in the form of durian, mangosteen, jackfruit, banana, petai and cardamom; and fourth, various food crop products are produced from rice, cassava, sweet potatoes, beans, chilies, and so on, including a variety of livestock products from chickens, sheep, goats and cows.

The variety of IPPF commodities cultivated by farmers is an adaptation strategy and anticipation of dryland farmers to face all the worst possibilities (especially in the dry season) and to get optimal benefits from the limited water and dryland resources they have. Coen et al. (1992) asserted that the reciprocal relationship between crops and livestock (especially in the use of waste) will reduce production costs and optimize the income of farmers' families and/or ranchers. In addition, the development of livestock business is a way to increase the variety of sources of income.

For IPPF dryland farmers, livestock also serve as annual, medium-term savings in addition to being a means to plough the land and being a source of organic fertilizer that can increase soil fertility. Tanaka, Karn, and Scholljegerdes (2008) confirmed that the integration of agricultural crops with livestock has a multiplier effect as follows: (1) producing manure that fertilizes the soil and saves costs; (2) encouraging the community to graze their livestock on agricultural lands so that their activities and excreta can improve soil quality; (3) provoking the presence of biodiversity (plants and insects) that can assist the process of pollinating plants, controlling weeds and managing pests; (4) providing social benefits (building livestock culture, interacting with each other) to farmers and rural communities; (5) increasing crop yields (productivity); and (6) increasing economic benefits for farmers.

In general, almost half of the farmers (41.71%) stated that IPPF contributed to the economy of farmers and communities in dryland agroecosystem zones (see Table 1). The majority (75.20%) of farmers stated that IPPF is sufficient and very functional as a source of agricultural products, food crops, vegetables, fruits and livestock (food sources) as well as plantation and forestry crops. IPPF is also recognized (73.60%) as a continuous source of income (70.80%), and relatively stable (74%). In addition, IPPF is also a provider of main employment (75.60%) and secondary employment (85.60%) for farmers and rural communities in general.

**Table 1.** IPPF economic function.

| No. | Economic Function of IPPF | Function Level | | | | | Total | Percentage of Function (%) | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | VL | L | F | H | VH | | VL | L | F | H | VH | |
| 1. | Source of various agricultural products | 2 | 60 | 166 | 20 | 2 | 250 | 0.80 | 24.00 | 66.40 | 8.00 | 0.80 | 100 |
| 2. | Income Source | 1 | 65 | 161 | 23 | 0 | 250 | 0.40 | 26.00 | 64.40 | 9.20 | 0.00 | 100 |
| | - Income continuity | 0 | 41 | 32 | 168 | 9 | 250 | 0.00 | 16.40 | 12.80 | 67.20 | 3.60 | 100 |
| | - Income stability | 0 | 65 | 101 | 78 | 6 | 250 | 0.00 | 26.00 | 40.40 | 31.20 | 2.40 | 100 |
| 3. | Main employment provider | 2 | 6 | 53 | 164 | 25 | 250 | 0.80 | 2.40 | 21.20 | 65.60 | 10.00 | 100 |
| 4. | Side job provider | 1 | 34 | 84 | 130 | 1 | 250 | 0.40 | 13.60 | 13.60 | 33.60 | 52.00 | 100 |
| Total | | 6 | 271 | 597 | 583 | 43 | 1500 | 0.40 | 18.07 | 39.80 | 38.87 | 2.87 | 100.00 |

**Note:** VL (Very Low), L (Low), F (Fair), H (High), VH (Very High).

Based on the results of the analysis, it is known that IPPF productivity has the potential to be increased because it is still considered low (24.40%). The assumption is, if productivity is increased, the income from IPPF, which is classified as sufficient (64.40%) and low (26.40%), has the potential to experience a significant increase. In fact, for some farmers (9.20%) it can increase several times. IPPF productivity and income can be optimized if production factors, such as human, capital and natural resources, can be managed and utilized properly. Utilization of the four production factors embodies farming technology in the form of arable land area (farming scale), number of livestock (livestock business scale), use of labor, capital, determination of cropping patterns, and selection of the most profitable business.

According to the Food and Agriculture Organization FAO (2017), high integration of crops and livestock is often considered a step forward. The condition is that small farmers must have adequate access to knowledge, assets and production inputs to manage an integrated farming system that is economically and environmentally beneficial in the long term (sustainable). In real terms, seen from its continuity and stability, the income from IPPF has the potential to be optimized because it is still relatively sufficient (12.80%) and discontinuous (16.40%). Logically, the income from IPPF must be continuous because it cultivates many agricultural commodities on land that is integrated with livestock business. This means that IPPF farmers have various sources of income (polyculture) in the short term (one season, one year) and long term.

In the cacao–coffee–coconut–banana and sheep/goat farming patterns, farmers have a source of income from cocoa plants every two weeks. The proposition is that cacao is a plant that can be harvested 24 times a year. Subsequent harvests are from coffee plants, which are harvested once a year, as well as from coconut and banana plants, which are harvested every month. In addition, farmers also receive income from livestock business, which is harvested according to a more flexible period because livestock usually function as family savings and will only be sold if there is a sudden and urgent need (such as celebrations, deaths, children's schooling, and others).

**Table 2.** Season calendar.

| Phenomenon Or Activities \ Month | January | February | March | April | May | June | July | August | September | October | November | December |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Wind | # | | | | | | | | ### | ### | ## | # |
| Rain | 🌧 | | | | | | | | | 🌧 | 🌧 | 🌧 |
| Garden Processing | | | | | | ◊◊ | ◊◊◊ | ◊◊◊ | ◊◊ | | | |
| Planting | | ΔΔΔ | | | | | | | ΔΔΔ | ΔΔΔ | ΔΔ | ΔΔ |
| Harvesting | | | | | | | | | | | | |
| - *Coconut* | √ | √√ | √√ | √√ | √√ | √√ | √√ | √√ | √√ | √ | √ | √ |
| - *Banana* | √√ | √√√ | √√√ | √√√ | √√√ | √√√ | √√√ | √√√ | √√ | √√ | √√ | √√ |
| - *Clove* | | √√ | | √√√ | | | | | | | | |
| - *Cocoa* | | | √√√ | | | | √√ | | | | √ | |
| - *Cardamom* | | | √√√ | | | √√ | | √√√ | | | | |
| - *Nutmeg* | | | √√ | | | √√√ | | √√ | | | | |
| Famine | | | | | 🧍 | 🧍🧍 | | 🧍🧍 | | 🧍 | | |
| Disease | Flu<br>Caterpillar pest<br>Black leaf | | | | | | | | Flu<br>Caterpillar pest<br>Black leaf | Flu | | |
| Work outside the village | | | | | | ooo | ooo | ooo | | | | |
| Marketing | □□ | □□ | □□ | □□□□□ | | | □□□□□ | □ | □□□□□ | | □ | |

**Note:**

- Different symbols indicate different phenomena/activities (in each month).
- The number of symbols in one column indicates the frequency of occurrence of phenomena/activities that occur in each month.

Explanation:

1. Wind: Wind has a role in the process of forming rain. Wind carrying particles known as aerosols encounter water vapor. The water vapor then condenses around the particles and turns into water droplets. Water droplets collect to form clouds, then fall to the earth in the form of rain. At the research location, it was observed that wind phenomena occur in January, September, October, November and December. Where in September-November wind phenomena occur more often than other months.
2. Rain: Rain occurs in January, October, November, December along with the phenomenon of the wind season.
3. Garden/Land Processing: Farmers cultivate the land in June-September, which is before the onset of the rainy season. In general, farmers mostly carry out land management activities in July-August.
4. Planting: Planting activities are carried out when water availability increases, namely in the rainy season in February and September-December. In general, farmers carry out planting activities more in February, September and October.
5. Harvest: Farmers in the study area can harvest almost every month from coconut and banana commodities, while other commodities such as clove, cocoa, cardamom and nutmeg can harvest 2-3 times a year.
6. Famine: The famine phenomenon occurs in May-October which coincides with the dry season. The most severe period is the June-August period.
7. Disease: Disease is a phenomenon that occurs due to changing seasons from the rainy season to the dry season.
8. Working outside the village: during the dry season when the planting process has not been carried out, more villagers go outside the city to look for work other than agriculture.
9. Marketing: This marketing activity is carried out during the harvest season. And the most is in the period of April, July and September.

The results of in-depth interviews with informant farmers (Mulyadi: Head of Tunas Mekar Farmer Group) related to the seasonal calendar (see Table 2) show that the many and varied agricultural and livestock commodities cultivated by farmers through IPPF have resulted in crop and livestock harvests being carried out every time. Coconut plants are harvested every month. In fact, the highest production occurs from February to September and will experience a decline during October to January. This happens because in the February–September period, rainfall begins to decrease, and sunlight, which helps the photosynthesis process, is maximized resulting in increased production. Another crop that can be harvested every month is bananas. In fact, production will be maximal from February to August and will decrease from September to January. In general, cloves are harvested in March/April, and cocoa/chocolate is harvested in March, July and November. In March, June and August, farmers harvest cardamom and nutmeg.

All of this confirms that the production results from IPPF are obtained by farmers almost every month, even in the same month several types of commodities can be harvested. With such conditions, marketing of agricultural products can be done every month or several times a month so that farmers' income becomes continuous. Empirically, most of the marketing of agricultural products is done in April, July and September. Other than that, marketing is carried out in January, February, March, August and November. Singh, Chambliss, and Sharma (1997) asserted that the integration of crops in various areas of land ownership tends to be more profitable than monoculture farming activities, and it also creates more jobs. Thamrongwarangkul (2001) acknowledged that agricultural diversification always increases the use of labor, reduces unemployment in areas with a surplus of labor and provides a source of livelihood for those who work in agriculture. This shows that IPPF provides job opportunities for local residents both as a main job (65.60%) and as a side job (52.00%). This means that IPPF and the agricultural sector in general are sectors that have an important role in supporting the economy of residents in dryland agroecosystem zones.

### *3.2. Socio-cultural Functions*

In addition to economic functions, IPPF also provides socio-cultural benefits for farmers and communities in dryland agroecosystem zones. Hilimire (2011) asserted that communities can benefit from the diversity of plant/livestock species. Indeed, integrated farming (polyculture) has the capacity to produce more energy than homogeneous farming (monoculture).

The results of the current study (see Table 3) reveal that IPPF raises public awareness to participate in institutions (80%) and some are even involved in 2–3 agricultural and rural institutions (1.60%). Several institutions that exist in the dryland agroecosystem zones are farmer groups, including women farmer groups (KWT), Family Welfare Development (PKK), Village Consultative Body (BPD) and religious institutions (DKM). However, farmer participation needs to be strengthened because there are still around 20% of farmers who have not been involved in institutions.

**Table 3.** IPPF socio-cultural functions.

| No. | Function of IPPF | Function Level | | | | | Total | Percentage of Function (%) | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | VL | L | F | H | VH | | VL | L | F | H | VH | |
| 1. | Farmers' activities | 0 | 0 | 28 | 198 | 24 | 250 | 0.00 | 0.00 | 11.20 | 79.20 | 9.60 | 100 |
| 2. | Farmers' participation room | 18 | 15 | 38 | 79 | 10 | 250 | 7.20 | 6.00 | 51.20 | 31.60 | 4.00 | 100 |
| 3. | Farmers' group activity room | 43 | 1 | 122 | 81 | 3 | 250 | 17.20 | 0.40 | 48.80 | 32.40 | 1.20 | 100 |
| 4. | IPPF experience sharing platform | 95 | 72 | 44 | 20 | 19 | 250 | 38.00 | 28.80 | 17.60 | 8.00 | 7.60 | 100 |
| 5. | IPPF cultural regeneration forum | 175 | 28 | 5 | 2 | 40 | 250 | 70.00 | 11.20 | 2.00 | 0.80 | 16.00 | 100 |
| 6. | Community culture space | 9 | 1 | 68 | 170 | 2 | 250 | 3.60 | 0.40 | 27.20 | 68.00 | 0.80 | 100 |
| Total | | 340 | 117 | 265 | 550 | 98 | 1500 | 22.67 | 7.80 | 17.67 | 36.67 | 6.53 | 100.00 |

**Note:** VL (Very Low), L (Low), F (Fair), H (High), VH (Very High).

For farmers, institutions in rural areas, especially farmer groups, are a place for discussion, deliberation, exchanging information, mutual cooperation (including improving agricultural facilities and infrastructure) and a space for cooperation in planning farming activities, procuring production facilities, Organizing joint extension activities and accessing assistance from the government with Field Agricultural Extension Officer. Strictly speaking, IPPF contributes as a forum for community activities (79.20%). Compared to farming communities in the upland and highland agroecosystem zones, farmers in dryland agroecosystem zones have a stronger level of participation, social capital and mutual cooperation (Setiawan, 2012).

For farming communities in dryland agroecosystem zones, IPPF has a high social function as a space for farming activities, a space for participation and a space for farmer group activities. Although the role of IPPF's cultural regeneration room is quite high (16%), overall, IPPF's social function as a space for sharing farming experiences, regeneration space and space for strengthening community culture still needs to be strengthened because it is perceived as weak. Apart from the weak institutional attractiveness, the low participation of farmers in institutional activities also tends to be influenced by the frequent clashes between the timing of these activities and farming activities.

In fact, the main factor for the weak participation of farmers is the unattractiveness of group activities. So far, extension activities have focused more on farming food crops, especially rice, corn and soybeans, while there are very few activities for other crop commodities that are in accordance with the culture of the dryland communities. In fact, most of the farmers in dryland agroecosystem zones do not cultivate much of these three commodities. Therefore, innovation and extension approaches are needed that are more in line with the needs and problems faced by farmers in dryland agroecosystem zones.

Historically, IPPF has long been entrenched in farming communities in dryland agroecosystem zones. In fact, it has become a farming method that has been passed down from one generation to the next. IPPF has become the norm and is developed based on local wisdom. Historically and empirically, the cropping pattern applied by farmers is the result of a long journey of adaptation of farming to various factors, such as climate, soil, economy, culture and markets. With the ability to think, farmers are able to change and adapt to the situation by finding technology (local knowledge) to improve the condition of their crops (Setiawan, 2008).

In general, most of the farmers are IPPF cultured (see Table 3). In fact, 62% of farmers have applied IPPF for more than 10 years. This means that IPPF has become an inseparable activity of the dryland farming community in West Java. In fact, 70% of IPPF knowledge was inherited, while the rest came from fellow farmers, farmer groups, extension workers and personal experiences. Due to local wisdom and knowledge, IPPF has become a value system for the life of dryland communities that is integrated with religion, culture and customs. The dry and forest-dependent nature requires communities to adapt by developing knowledge, ideas and tools that are guided by customary norms and cultural values in managing the environment to meet their daily needs. Socio-culturally, IPPF has become the culture of the dryland community in West Java.

### *3.3. Environment Function*

Russelle, Entz, and Franzluebbers (2007) stated, before the agricultural industry developed, the function of agroecosystems in traditional community farming systems in dryland agroecosystem zones had been designed adaptively according to its complexity and diversity. For people in dryland agroecosystem zones, cropping systems and cropping patterns that integrate crops and livestock are social capital. IPPF conducted on drylands faces many problems. Therefore, land use is always regulated so that it is in harmony with its conditions and carrying capacity. If you don't pay attention to the principles of conservation, then agricultural cultivation on drylands with a high slope can result in lean and critical land.

As one of the areas located in the ring of fire (volcanoes) and earthquake pathways, Tasikmalaya Regency is prone to landslides. Therefore, the use and management of drylands must be done wisely. This means that efforts must be made to maintain and prevent the factors that cause land damage based on conservation principles. Farming and settlements must be designed to be adaptive to natural conditions and anticipatory to all possibilities. IPPF is one approach that has an environmental function (see Table 4).

More than half of the farmers (54.80%) acknowledged that IPPF is able to control erosion, and some farmers (39.20%) stated that erosion had never occurred, i.e., IPPF can minimize erosion. The existence of stands and various commodities cultivated on drylands are able to absorb forest water and minimize surface runoff. In general, erosion is related to various factors, especially the slope of the land. Sloping land has a higher potential for erosion than flat land. Therefore, if there is a slight mistake in the application of the agricultural system in conservation areas, disaster will be inevitable and the community will feel the impact. Nasution (2004) asserted that the acceleration of erosion in the upstream watershed, which causes land to become critical, is not only due to the damage to the physical environment and local climate change, but is also triggered by land management methods that are not in accordance with conservation principles. The results obtained by Arsyad (2007) prove that erosion and runoff are the main causes of environmental damage of drylands in Indonesia. The impact is not only erosion (decreased physical, chemical, biological and land productivity) upstream, but also has increased and expanded flooding, sedimentation, pollution and socio-economic conditions in downstream communities.

**Table 4.** IPPF environmental functions.

| No. | Function of IPPF | Function Level | | | | | Total | Percentage of Function (%) | | | | | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | VL | L | F | H | VH | | VL | L | F | H | VH | |
| 1. | Soil and Water Conservation | | | | | | | | | | | | |
| | Erosion Control | 2 | 1 | 12 | 137 | 98 | 250 | 0.80 | 0.40 | 4.80 | 54.80 | 39.20 | 100 |
| | Terraces | 15 | 53 | 81 | 90 | 11 | 250 | 5.60 | 21.20 | 32.40 | 39.20 | 1.20 | 100 |
| | Erosion Occurrence | 3 | 8 | 28 | 156 | 55 | 250 | 1.20 | 3.20 | 11.20 | 62.40 | 22.00 | 100 |
| | Heading Density | 0 | 10 | 12 | 210 | 18 | 250 | 0.00 | 4.00 | 4.80 | 84.00 | 7.20 | 100 |
| | Root System | 0 | 7 | 111 | 121 | 11 | 250 | 0.00 | 2.80 | 44.40 | 48.40 | 4.40 | 100 |
| | Flood Control | 2 | 4 | 4 | 46 | 194 | 250 | 0.80 | 1.60 | 1.60 | 18.40 | 77.60 | 100 |
| | Water Stock | 1 | 8 | 104 | 131 | 6 | 250 | 0.11 | 1.81 | 35.33 | 59.34 | 3.40 | 100 |
| | Soil Porosity | 0 | 0 | 12 | 212 | 26 | 250 | 0.00 | 0.00 | 4.80 | 84.80 | 10.40 | 100 |
| 2. | Pollution Control | | | | | | | | | | | | |
| | Air Freshness | 0 | 19 | 10 | 165 | 56 | 250 | 0.00 | 7.60 | 4.00 | 66.00 | 22.40 | 100 |
| | Air Comfort | 0 | 0 | 41 | 162 | 47 | 250 | 0.00 | 0.00 | 16.40 | 64.80 | 18.80 | 100 |
| 3. | Biodiversity Protection | | | | | | | | | | | | |
| | Existing Biodiversity | 0 | 1 | 59 | 162 | 28 | 250 | 0.00 | 0.40 | 23.60 | 64.80 | 11.20 | 100 |
| | Forage Utilization | 2 | 1 | 80 | 89 | 78 | 250 | 0.80 | 0.40 | 28.40 | 35.60 | 31.20 | 100 |
| | Waste Recycling | 43 | 36 | 61 | 104 | 6 | 250 | 17.20 | 14.40 | 20.80 | 41.60 | 2.40 | 100 |
| | Use of Organic Fertilizer | 1 | 2 | 15 | 151 | 81 | 250 | 0.40 | 0.80 | 6.00 | 60.40 | 32.40 | 100 |
| Total | | 69 | 150 | 630 | 1936 | 715 | 3500 | 1.92 | 4.19 | 17.04 | 56.04 | 20.27 | 100 |

**Note:** VL (Very Low), L (Low), F (Fair), H (High), VH (Very High).

IPPF is very effectively adopted by farmers in Southwest Java because 25.60% of farmers' land has a high slope and 45.20% is moderately sloped. In general, only 29.20% of farmers' land is categorized as sloping or flat. Even though the land slope is high, with IPPF, the erosion rate can be minimized (1.20%). In fact, with IPPF, 94% of farmers' land is safe from landslides or erosion (see Table 4). The results of the study on the slope of the land show that most of the respondents (45.20%) stated that the condition of the land in the study location was categorized as being quite sloping, so the land in the research location had the potential to experience erosion. One of the efforts to minimize the occurrence of erosion is to implement mechanical soil conservation techniques through the use of terraces. Arsyad (1989) explained that the construction of terraces serves to reduce the length of the slopes and retain water thereby reducing the speed and amount of runoff so as to allow absorption by the soil and reduce erosion.

The results of the data tabulation on the condition of the terraces at the research site, most of the respondents (39.20%) stated that they were in good condition (see Table 4). Terrace construction aims to change the sloping ground surface to reduce the velocity of runoff and hold water so that it is absorbed into the soil through the infiltration process (Sarief, 1986). Furthermore, Yuliarta (2002) stated that terraces are useful for reducing the velocity of surface runoff so that the erodibility of the soil and erosion is minimized but the infiltration of water into the soil is enlarged and accommodates and controls the speed and direction of runoff to a lower place safely.

Respondents' understanding of the role of IPPF in minimizing erosion is indicated in Table 4. Most of the respondents (62.40%) agreed that erosion occurred due to the reduction in IPPF land. Therefore, IPPF has a very important role to overcome the occurrence of erosion because it is a farming method that is carried out with a multi-crown system. This cropping pattern can utilize sunlight and soil in layers to increase land productivity while protecting the soil from damage and preventing soil fertility from decreasing through natural mechanisms. A very good conservation system is a multistrata system utilizing shade from trees because the canopy layer is able to provide a good conservation function to reduce erosion (Agus, Ginting, & Noordwidjk, 2002; Mulyoutami, Endy, Wim, Subekti, & Laxman, 2004).

**Figure 1.** The roots of dead trees (Photo: Meine and Willigen (1986)).

Figure 1 depicts the important role of burrows formed from the roots of dead trees. The soil in the burrow is darker and looser than the surrounding soil so more roots will grow following the burrow to the bottom layer. Dead tree roots form burrows in which cassava roots grow through the undercoat of ultisols.

The criteria for canopy capacity, according to 84.00% of the farmers, 7.20% of the respondents said that the canopy capacity was very tight. Furthermore, 4.80% of respondents stated that the editorial capacity was less dense, 4.00% stated that the editorial capacity was less dense, and none of the respondents stated that the canopy capacity was open.

Furthermore, Arsyad explained that vegetation has an effect on runoff and erosion, namely reducing the speed of runoff and the destructive power of rain, the interception of roots, and the influence of roots and organic matter.

Furthermore, Arsyad (2006) explains that vegetation has an effect on surface runoff and erosion, namely reducing the speed of runoff and the strength of rain destroying, root interception, as well as the influence of roots and organic matter. IPPF root system, stated by most respondents (48.40 percent) deep and 4.40 percent stated very deep (Table 4) because IPPF cultivates long-lived plants that have roots that are able to form burrows in the soil to the bottom layer so as to improve hydrological function and water management. Deep tree roots can also improve nutrient recycling, reduce erosion hazards, improve soil porosity, and so on.

The criteria for soil pore capacity, as stated by 84.80% of respondents, are good soil condition and the potential for floods. Most of the respondents (77.60%) stated that there had never been a flood and 63.60% of respondents agreed that a flood occurred because of the reduction in IPPF land. Regarding water availability, 59.34% of respondents stated that the availability of incoming water was in the available criteria. IPPF is a polyculture farming method that is dominated by the exploitation of woody plants and plantation crops. These plants produce continuous organic matter from fallen leaves, branches, twigs, dead plant roots and soil animals, resulting in crumbly soil which has a high infiltration level. Increasing groundwater infiltration and water absorption by plants will reduce surface water runoff, thus reducing the risk of flooding and ensuring water availability.

This is essential because the main limiting factor for dryland farming is the availability of water due to low rainfall. Meeting the water needs for farming in general relies on rainwater. Meanwhile, climatic conditions that occur over time and between regions experience changes in water, so IPPF is a farming system which is also an efficient and effective water management system.

Human activities that use fossil fuels for power generation, transportation and industry, including activities related to land conversion to provide new land for agriculture (including plantations) and settlements have increased greenhouse gas (GHG) concentrations. These gases in the atmosphere can cause changes in the radiation balance so that it increases the temperature of the earth's atmosphere. The largest major GHG produced by human activities with very large emission rates is carbon dioxide ($CO_2$). This gas is often used as a standard or reference for changes in composition and global climate change (Widianto, Suharjito, & Sarjono, 2003).

Regarding the freshness and comfort of the air, most of the respondents (66.00%) stated that the freshness of the air was included in the fresh criteria and 64.80% stated that the comfort of the air was included in the comfortable criteria. Widianto et al. (2003) explained that the potential of terrestrial ecosystems to reduce $CO_2$ in the air depends on the type of ecosystem, species composition, plant structure and distribution of plant age. Other influencing factors include local conditions such as climate, soil conditions, natural disturbances and types of land management.

IPPF is a farming business with various components of the land cover system (plantation, timber, horticulture, food and livestock) and generally has a long lifespan. This has an influence on the input of litter that occurs continuously and varies in quality so that the "stay" above ground level also tends to be longer. Planting systems on drylands can reduce $CO_2$ gas through the process of photosynthesis and then stockpile it as C-organic in the plant body (biomass) and soil for a long time (30–50 years) (Hairiah & Rahayu, 2007). C-organic content is an element that can determine the level of soil fertility.

The land use system affects the maximum age of the land and also the carbon stock contained in it (Table 5). Carbon stock is the carbon content stored either on the soil surface as plant biomass, dead plant residues (necromass), or in the soil as soil organic matter.

**Table 5.** Carbon Stock per crop rotation of various land use systems.

| No | Land Use System | Maximum Age (years) | C Reserves Per Cropping Rotation, Mg Ha-1 |
|---|---|---|---|
| 1 | Natural Forest | 120 | 254 |
| 2 | Secondary Forest | 60 | 176 |
| 3 | Rubber Agroforestry | 40 | 116 |
| 4 | Rubber Plantation (monoculture) | 25 | 97 |
| 5 | Grass fallow rotation | 7 | 74 |
| 6 | Cassava-reed rotation | 3 | 36 |

**Source:** Tomich et al. (1998) in Widianto et al. (2003).

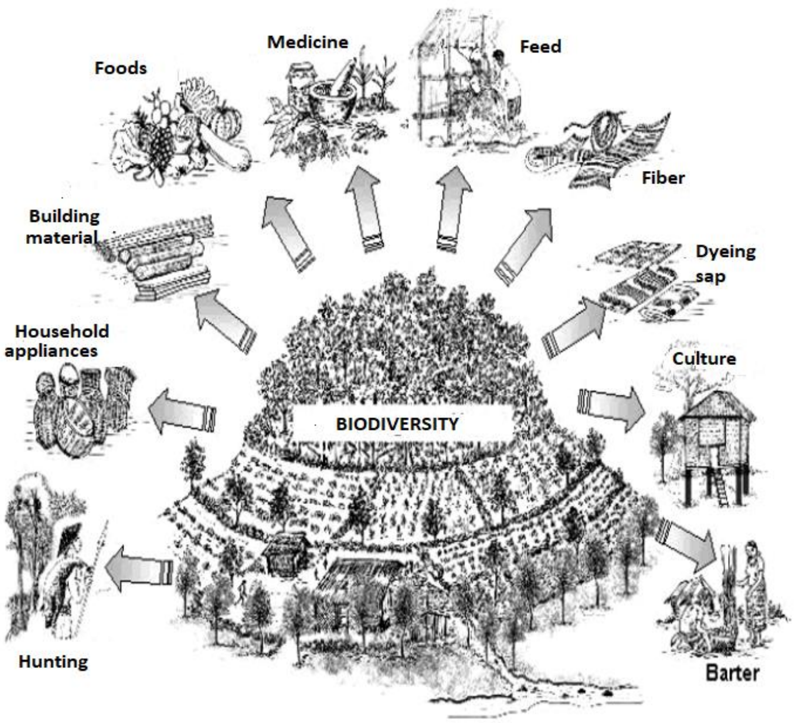


**Figure 2.** Uses of biodiversity for communities (IRRI (2001)).

During the growth phase, plants photosynthesize, which requires sunlight, $CO_2$ from the air, water, and nutrients from the soil. Thus, the presence of plants can reduce the concentration of $CO_2$ in the atmosphere and the result is carbohydrates, which accumulate in the plant biomass. The level of $CO_2$ absorption in the atmosphere varies depending on the type of plant constituent and the age of the land. According to Collins et al. (1999), one indicator of the success of soil management efforts is the maintenance of C reserves so that the balance of the environment and biodiversity can be maintained.

Biodiversity is the variety of living things, including animals, plants and microorganisms and various genera and the ecosystem complexes that support them, that have existed on earth for hundreds or even thousands of years (McNeely & Scherr, 2001), and is something that must be protected (see Figure 2).

The biodiversity reported by most of the respondents (64.80%) was in various conditions (see Table 4). IPPF respondents operate more than one agricultural crop commodity and livestock business. Biodiversity needs to be protected or maintained for several reasons: 1) until now, we have been very dependent on nature as a source of food, medicine, etc.; 2) in the future, genetic diversity is needed for plant selection, food production, etc.; 3) ecosystems function as guardians of ecosystem stability; 4) culture and spirituality function as sources of inspiration; 5) the moral aspect, which states that all species have the right to exist in nature (Widianto et al., 2003).

Funes-Monzote (2008) stated that more diverse species have been found in integrated farming than in farms where only one type of plant or livestock is cultivated. The simple fact is that by integrating livestock there will be at least more than one species; this does not include the biodiversity that arises from the addition of land for animal feed, which can increase the population of insects and other wild animals (Brunson & Huntsinger, 2008).

IPPF produces various types of forage originating from polyculture plants and from various types of weeds that grow in IPPF areas. This waste has the potential to be used as a source of animal feed for sheep, goats and cattle. Meanwhile, organic material is produced from livestock business that has the potential to be used as raw material for organic fertilizer that is applied to cultivated plantation polyculture plants. The results of a study on the use of forage as animal feed showed that 35.60% of respondents stated that they often used IPPF forage as animal feed, 31.20% always use IPPF forage as animal feed, 28.40% sometimes use it, and only 0.40% and 0.80% of respondents stated that they rarely and never used IPPF forage as animal feed.

Subagyono (2004) explains that several plantation crop commodities support the integrated system model in relation to plantation areas, including rubber, coconut, palm oil and others, which have the potential to support the development of livestock business. These potentials are: 1) land use among plantation crops (rubber, coconut, palm oil, cloves, coffee), and 2) utilization of waste from staple crops and intercrops as well as factory waste (palm oil, coconut and cocoa). Priyanto, Priyanti, and Inounu (2004) stated that cocoa husks can reduce the portion of grass feeding, especially in an intensive pattern because cocoa skin is one of the prospective goat feed ingredients that supports the creation of a cocoa–goat integration model.

Livestock business carried out in IPPF also produces cage waste from livestock manure and leftover feed that is not eaten by livestock. This waste also has the potential to be used as a source of organic material for the manufacture of organic fertilizers. Katyal, Rao, and Reddy (2001) stated that organic soil matter is a basic element for soil fertility, land productivity and land quality. Therefore, the existence of organic soil matter must be maintained in a sustainable land management system.

A study of IPPF waste recycling shows that 41.60% of respondents stated that they often recycle IPPF waste, 2.40% of respondents said they always carried out the IPPF waste recycling process, 20.20% said sometimes, 14.40% said rarely, and 17.20% stated that they had never recycled IPPF waste.

IPPF waste recycling results in organic fertilizer obtained from the decomposition process of organic matter originating from polyculture plant waste (decayed leaves, fruit peels, forage from pruning residue, weeds, and inedible and livestock manure). This organic fertilizer can be used by farmers on the polyculture plants they cultivate. The results of the study on the use of organic fertilizers show that as many as 60.40% of respondents said they often use organic fertilizers on their polyculture fields, 32.40% said they always use them. Only 6.00%, 0.8% and 0.4%, respectively, stated that they quite often, rarely and very rarely use organic fertilizers on their farming land.

Russelle et al. (2007) stated that integrated agriculture is not a new phenomenon and that the agricultural system before the emergence of the agricultural industry was carried out based on complexity and diversity. Livestock are an integral part of farming and animal husbandry in the US and are used for tillage and fertilization for crop production. Forita, Suratman, and Slamet (2011) explained that an integrated farming system implemented by farmers can guarantee soil conditions that support plant growth, especially through organic matter management. Plant and livestock farming has a high functional linkage so that external inputs can be reduced.

### *3.4. Farmers' Household Income Exchange Rate (FHIER) of IPPF Farmers*

FHIER is an indicator that is used to determine the welfare of farmers' households. This FHIER is the ratio of the total income to the total expenditure of a farmer's household. Total household income is the sum of all agricultural production values and non-agricultural businesses. Meanwhile, total household expenditure is the sum of all expenditures made by farming families (Simatupang & Mohamad, 2007). FHIER can determine whether a farming family is only able to meet their daily needs with the income earned, or whether a farmer has been able to allocate household income to other desires besides basic household needs.

Table 6 shows IPPF farming families in Tasikmalaya Regency who are, on average, already categorized as prosperous with a FHIER value of 1.45. This shows that IPPF farming families have a surplus of income and are able to meet all their expenses. The FHIER value achieved by IPPF farmers in Tasikmalaya Regency is higher than that achieved by dryland farmers in Tanggamus Regency, Lampung Province, which is only 1.07 (Reni, Rudi, & Susni, 2016). This shows that IPPF dryland farmers in Tasikmalaya Regency are more prosperous than dry land farmers in Tanggamus Regency even though both are categorized as prosperous.

**Table 6.** FHIER of IPPF in Tasikmalaya regency.

| No | Component | Rupiah |
|---|---|---|
| 1 | Income | 18.689.712.90 |
| | 1. Agriculture | 10.899.952.90 |
| | 2. Non-Agricultural | 7.789.760.00 |
| 2 | Production cost | 1.494.673.14 |
| 3 | Consumption | 13.255.806.40 |
| | 1. Food | 6.240.128.00 |
| | 2. Non-Food | 7.015.678.40 |
| 4 | Total Expenditure | 14.750.479.54 |
| 5 | Income Exchange Rate Against | |
| | 1. Production Cost | 22.94 |
| | 2. Food Consumption | 4.48 |
| | 3. Non-Food Consumption | 4.88 |
| | 4. Total Consumption | 1.66 |
| | 5. Total Expenditure | 1.45 |

Furthermore, when the FHIER is compared to total consumption (1.66) and production costs (22.94), it shows that farmer households spend more of their income on meeting consumption needs than IPPF production costs. This is due to the expenditure of farmers on IPPF costs only according to their needs depending on the production process of the plant, while the consumption needs of both food and non-food must be met every day.

Furthermore, FHIER for food consumption (4.48) and non-food (4.88) shows that FHIER for non-food consumption is greater than FHIER for food consumption. This means that IPPF farming families prioritize non-food items/services over food. This is because farming families cannot make adjustments for non-food needs, such as education and transportation. Farmer families cannot determine prices/costs for education and transportation. The price/cost is determined by an external party (other than the farmer), so like it or not, the farmer have to pay the cost of education and transportation. Meanwhile, for food consumption, IPPF farming families can make adjustments according to the available budget.

## 4. CONCLUSION

Farmers in general (41.71%) stated that IPPF contributed to the economy of farmers and their communities. Most of the farmers (75.20%) stated that IPPF is sufficient and functions well as a producer of agricultural products, 73.6% stated that IPPF functions as a source of income in sufficient and high categories. It is also stated as being a continuous source of income (70.80%), quite stable (74%), and serves as a main job provider (75.60%), and a side job (85.60%). IPPF has a high social function, but overall, the social function of IPPF is as a space to share farming experiences, a space for regeneration and a space for strengthening community culture, which still needs to be strengthened because it is considered weak. The environmental function of IPPF makes the soil crumbly with high infiltration to reduce surface water runoff, reduce flood hazards and ensure water availability. IPPF also produces forage from polyculture plants as animal feed, and 66.80% of farmers have used the forage for animal feed. From livestock businesses, organic material is produced as a raw material for organic fertilizer, and 92.80% of farmers often use organic fertilizer to reduce pollution.

IPPF farming families in Tasikmalaya Regency are categorized as prosperous families (FHIER > 1); farming households spend more income on meeting consumption needs (FHIER = 1.66) compared to IPPF production costs (FHIER = 22.94), and non-food consumption (FHIER = 4.88) was greater than food consumption (FHIER = 4.48).

## 5. POLICY IMPLICATIONS

It is necessary to develop local superior commodities with regard to the fact that, in general, farmers have diverse methods of planting the commodities they cultivate so they do not focus on developing specific business processes. An increase in added value is needed to increase income and expand employment opportunities because, so far, farmers are still selling their produce in the form of fresh or raw materials. It is necessary to increase cooperation between fellow farmers in groups and associations, and build networks with external parties (e.g., agroindustrial companies, wholesalers, financial institutions, universities, and research and development institutions), which are important capital for the development of IPPF. Regeneration of farmers was necessary because most of the IPPF farmers were elderly, and the youth had little interest in being involved in IPPF.

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