

Food Security and Environmental Sustainability on the South Sumatra Wetlands, Indonesia

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ABSTRACT

The research aimed to analyze food security and environmental sustainability in the South Sumatra wetlands. This research conducted on the wetlands of Banyuasin Regency, By Using the Survey method interview with respondents, guided by a questionnaire through the Focus Group Discussion (FGD). All data collected, by analyzed with SPSS program. The results showed that plants planted in wetlands vary widely, such as rice, corn, soy, sweet potatoes, nuts, and cassava. The diversity of commodities is cultivated on high enough wetlands; they seek food farming in order to meet their own subsistence with little agricultural input, making it relatively difficult for crops to be able to produce optimally. The suitable land for food farming can be achieved if the Government has already applied appropriate technology and built infrastructure. Based on market access and population density, thus typology of agricultural land on wetlands can be classified as subsistence-based; cash crop-based;

continuous rice-based; extensive perennial-based crops; and vegetable-based crops. The main typology was dominated by continuous rice-based system taking around 197.961 ha or 58.50% and the lowest level was shown by vegetable-based crops around 20.998 ha or 6.20%.

Keywords: Food security, environmental sustainability, wetlands

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INTRODUCTION

Agricultural revitalization has triggered the acceleration of food productivity growth over the last three decades. The accelerated increase in food production, was expected to be a major factor in controlling poverty and improving food security, so that Banyuasin district has succeeded in conducting self-sufficiency at the national level (Armanto, 2019a; 2019b; 2019c; Junedi *et al.*, 2017;), besides increasing production is still needed to meet the high demand of food from other regions (Armanto *et al.*,

2017a; 2017b; 2017c; Wildayana, 2017). Rice is called as the main food (staple food) for Indonesian and about 76% of rice was produced on the marginally suitable wetlands as the main livelihood of farmers due to low productivity and inadequate water management, which causes poverty to be found on wetlands (Wildayana and Armanto, 2017; 2018c; 2018d). In addition, unfavorable climatic and environmental conditions (such as floods or droughts) have caused production instability and gripped the local population extensively, so the long-term effects on the poor are increasingly difficult to control. Furthermore, the risks posed by an unstable climate have led to a decrease in productivity; hence, farmers avoid large-scale investments because they are afraid of losing crops (Armanto *et al.*, 2013; 2016, Zuhdi *et al.*, 2019).

Rice farming systems on wetlands can be distinguished into tidal ricefields and *lebak* (fresh water swamp) ricefields. The main physical problems of ricefields are how to manage excess water properly, drought, flood, salinity and soil conditions (Sarno *et al.*,

2017; Wildayana *et al.*, 2018a; 2018b), high weeds and pest attacks, which disturb for rice planting and average yield of about 2.50-4.40 tons Dry Milled Grains (DMG)/ha/year (Zahri *et al.*, 2018; 2019). Because rice is a staple food

providing food security for farm households, interventions how to increase rice productivity can be an important entry point in starting and strengthening agricultural growth and income of farmers.

Improving sustainable rice productivity should be a realistic goal to be achieved on wetlands because it will have a major impact on rural poverty reduction through increased income of farmers. It can be implemented through the using superior rice varieties, applying fertilization, controlling pest and diseases, managing surface groundwater level, and being good farming management. Better resource management is often less able to achieve optimal productivity because a rice production increase on marginally suitable land for rice farming requires high agricultural inputs, and this means increased production costs (Wildayana, 2018a; 2018b). Furthermore, the vulnerability of farmers residing in this region is reinforced by the impact of the economic crisis, along with rising food prices and extreme climatic events, has led to substantial increases in poverty (Bergstrom, 2018; Fusco *et al.*, 2018; Firmansyah *et al.*, 2016).

The target of agricultural objectives is unlikely to be achieved without a targeted effort that directly addresses the main problem, namely poverty as a central point of rural development (Lamidi *et al.*, 2018). Poverty persists, especially in rural areas with poor access to markets, although nationally that substantial agricultural production growth has been achieved (Wildayana *et al.*, 2017a; 2017b; 2018). In theory, wetlands have an important role because these areas are rich in biodiversity - both in flora and fauna. It is also a water catchment area for many rivers that provide water for agriculture, industry, housing, and settlement, private and commercial sectors. Forest areas are critical to carbon dioxide, which is the main greenhouse gas (Tiezzi *et al.*, 2018; Tavakoli *et*

al., 2018; Kiggundu II et al., 2018). However, some of these important ecological functions will be degraded by agricultural activities in a broad sense, such as the negative impact of the *sonor* systems (shifting cultivation) that use fire. This system obviously has impacts that are more negative on the environment that does not support for sustainable agriculture (Imanudin et al., 2017; 2018; 2019; Holidi et al., 2018; 2019).

Government policies to extract the wetlands natural resources often generate conflict with local communities. Mainly ethnic minority groups, which are largely outside the mainstream of the national political process, inhabited the construction of wetlands; they are not the center of attention, resulting in an imbalance in the distribution of development (Wildayana and Armanto, 2017; 2019).

2. MATERIALS AND METHODS

This research belongs to the descriptive qualitative study that has been carried out on wetlands of Banyuasin District, South Sumatra Indonesia by using survey method. Respondents were collected using sample selection techniques of probability principles based on groups of farmers naturally gathered together. Data and information were collected by combining several research methods, such as literature reviews relating to the research theme, interview method with questionnaire and field observation. Interviews with respondents were guided by structured and unstructured questionnaires through the Focus Group Discussion (FGD). Structured questionnaires are intended to give the respondents the freedom to answer questions; meanwhile, unstructured questionnaires are intended to provide a choice of answers to be chosen by the respondents. All data collected were analyzed with

SPSS program and in the next stage comparison or relationship, analysis between variables was conducted.

RESULTS AND DISCUSSION

The research results will discuss the important components related to food security and environmental sustainability, namely rice farming on wetlands; transition of wetlands rice-based systems; why do farmers grow wetlands rice?; and critical entry points for food security and poverty reduction.

3.1 Rice Farming on Wetlands

Rice farming on wetlands has been practiced by farmers and assisted by the Government of Indonesia through transmigration programs and occurs in eastern part of South Sumatra. The rice farming is very heterogeneous with varying climates and the soils (from infertile to fertile). The rice yield growth rate has been enlarged during the period of around 30 years. It indicated that the transmigration program has led to improve only the planting rice area on the wetlands and has no direct impact on rice productivity. Imanudin et al (2017; 2018) also showed the similar finding.

There are three types of ricefields cultivated by farmers, namely *lebak* ricefields (covering an area of around 31,249 ha or 13.79%); tidal ricefields (area of approximately 166,712 ha or 73.60%) and other ricefields (including ricefields grown with the *sonor* system or not planted with rice, covering 28,557 ha or 12.61%). Until 2017, the area of wetlands cultivated as ricefields was around 226,518 ha. It accounts for about 36.99% of the entire ricefields in South Sumatra and accounts for 25.65% of the total rice production in South Sumatra Province (Table 1).

Table 1. Area and rice productivity of wetlands in Banyuasin

Nr	Ricefields	Area		Production	
		ha	%	(ton)	(ton DMG/ha/year)*/
1	<i>Lebak</i>	31.249	13.79	135.50	4.33
2	Tidal	166.712	73.60	763.95	4.58
3	Others	28.557	12.61	NA	3.51
	Total	226.518	100.00	899.45	4.14

Note: NA (no available data); DMG: Dry Milled Grains
Source: Field survey (2019).

Since rice is mostly planted together with other crops in which wetlands cultivation is practiced, the actual area of rice farming may be larger. The rice yield was generally low, however the average rice yield was around 4.58 ton DMG/ha/year for tidal ricefields and 4.33 ton DMG/ha/year for *lebak* ricefields, which was much lower than the technical irrigated ricefields (5.50 ton DMG/ha/year and lower than rainfed ricefields (4.63 DMG/ha/year). Zahri et al (2018) reported the same results for wetland areas.

Plants grown on wetlands vary also greatly, such as rice, corn, soybeans, sweet potatoes, nuts, and cassava. Ricefields are grown as rice monoculture or as intercropping plants with other cash crops. Although this diversity is quite high, but poor farmers occupy some of the key characteristics of wetlands, they seek food farming in order to meet their own subsistence farming and little agricultural input, making it relatively difficult for crops to be able to produce optimally. Danaan et al

(2018) found that poor farmers dominate subsistence farming.

3.2. Transition of Wetlands Rice-based Systems

The field data concluded that market access and population density are mentioned as two important components determining transitions of the overall rice production system on wetlands. Based on market access and population density, can be divided into five landuse typologies as summarized in Table 2. Thus typology of agricultural landuse on wetlands in Banyuasin district can be classified as subsistence system; cash crop-based; continuous rice-based; extensive perennial-based crops; and vegetable- based crops. The main typology was dominated by continuous rice-based system taking around 197.961 ha or 58.50% and the lowest level was shown by vegetable- based crops around 20.998 ha or 6.20%.

3.2.1 Subsistence-based Farming

Subsistence-based farming can be defined as self-sufficiency agriculture where farmers focus on cultivating food in sufficient quantities to meet the needs of their own families. The characteristic of subsistence agriculture is to have a variety of crops and animals to eat, sometimes fiber for clothing and building materials. It is common in crop farming while subsistence agriculture usually cultivates several types or mixtures of plants. Subsistence crops are also grown for livestock feed farmers including working animals. Farmers use the small amounts of land they own to produce enough crops for their own consumption, while a small portion of the yield is used in exchange for other goods. Farmers use simple equipment, and try to get maximum results by intensifying cultivation methods, including the preparation of ricefields that can be used every year. Fusco et al (2018) reported it also how drought affects agricultural insurance policies through agricultural production.

Table 2. Typology of agricultural landuse on wetlands in Banyuasin district

Nr	Farm typology	Acreage	
		ha	%
1	Subsistence-based	28.557	8.44
2	Cash crop-based	30.125	8.90
3	Continuous rice-based	197.961	58.50
4	Extensive perennial-based crops	60.778	17.96
5	Vegetable-based crops	20.998	6.20
		338.419	100.00

Source: Field survey (2019).

Decisions about which crops to plant usually depend on what the family wants them to eat in the coming year, also considering commodity prices in the market if they are overpriced, so farmers feel better to grow them themselves. Beside that, limited market access causes independent farmers to produce agricultural products to meet their own needs.

A small portion of subsistence-based farming products also make little trade in their agricultural produce (either by barter or buying and selling systems) for goods that have little effecting on their survival and which cannot be generated on the land, such as salt, bicycles, and others. Most subsistence farmers currently live in isolated areas and away from market access. Food security is related to sustainable intensification in the fields.

Some farmers sell their agricultural product in the local market (*Kalangan* market) to buy commodities such as foods (sugar, coffee, tea, salt); industrial products (fuel, needles, buttons, and yarns); medicine; hardware products (such as nails, wires, table, chair, working equipment); and leisure goods (such as candy, pen, books and papers). There are also a small percentage of farmers who want to pay for the services of doctors, veterinarians, blacksmiths, and others by bartering.

A part of the most common subsistence-based farming is the *sonor* system, a number of forest areas cleared by cutting and burning, and agricultural crops grown there. After two to three years of use, soil fertility begins to decline, leaving the land abandoned and farmers clearing new land. Land left slowly will experience succession into secondary forest and soil fertility slowly returns. After a decade, the farmers will return to the land. However, if there is an increase in the population, then the pressure of the population on the wetlands also increasing, and land clearing may occur more frequently and does not provide an opportunity for nature to restore its soil fertility. This results in deforestation and land degradation.

The *sonor* system is performed locally if the low population density and followed with limited market access were found, thus labor utilization would be minimized by applying slash and burn cultivation with on long periods of fallow (with rotation time over 10 years). If the increase in population pressure persists, especially on a limited area, farmers will intensify land use by reducing fallow periods and ultimately a transition to a continuous rice farming where rice grows annually. This *sonor* system occupied an area of around 28.557 ha or 8.44% and in each year the extent of the *sonor* system will

be reduced. Wildayana (2018b) also presented the similar phenomena.

3.2.2 Cash Crop-based Farming

Cash crop-based farming accounts for about 30.125 or 8.90% of total area of wetlands. The cultivated crops are usually crops that produce for the purpose of making money and the product is marketed for profit. Additional benefits are needed to fund subsequent planting activities, such as growing bananas, rice and others. Usually in cash crop-based farming was cultivated in form of monoculture management of plants. However, as the population pressure increases, employment is preferred to put more emphasis on the intensification of cash crops to increase agricultural production to meet subsistence food needs.

3.2.3 Continuous rice-based Farming

Continuous rice-based farming belongs to rice-farming monoculture, where farmers grow rice as their main commodity. The goal of monoculture planting is to increase agricultural yields. The advantages of this system are that the technical cultivation was relatively easy. On the other hand, the weakness of this system is that the plants are relatively susceptible to pests and diseases. The planting of monocultures leads to an unstable agricultural environment. The agricultural land has to be cultivated, fertilized, and sprayed with pesticides. Otherwise, crops are susceptible to pests and diseases. If pests attack the crops, then the pest will quickly attack a large area and farmers cannot harvest because pests attack the plants. The continuous rice-based farming dominated agricultural landuses and accounts for about 197.961 ha or 58.50% of the wetlands area.

As a result of the transition to a market-oriented system, continuous rice-based farming has declined every year for the past two to three decades. A major shift from continuous rice-based to plantation has occurred, where extensive rice-growing areas were converted to extensive perennial-based crops and vegetable-based crops also rising due to market demand.

3.2.4 Extensive perennial-based crops

Extensive perennial-based crops belonged to plantations, which are distinguished, from agro forestry and silviculture due to its intensive nature. Plantations play an important role in the regional development; plantations almost always apply monoculture system, such as oil palm and rubber and are distinguished from yard farming mainly because of the scale of their business and product

markets. Plantation size is very relative and depends on the volume of commodities produced. However, a plantation requires a minimum area to maintain profits through its applied production system. Land ownership is not an absolute requirement in plantations, so for some commodities there is a system of land leases or business-sharing systems, such as the Nucleus Estate System (PIR Plasma), the same performance of farmers in Nigeria.

With the improved market access, it opens up opportunities for farmers to integrate various commodities in the plantation production system. This will form an extensive annual plant-based typology. Ricefields were planted with rubber or oil palm on separate grounds or in empty spaces or rice planted among rows of young annual crops during the annual plant canopy, that have not closed all or in other words annual plant age of less than 3 years. Extensive perennial-based crops covered an area of around 60.778 ha or 17.96%.

3.2.5 Vegetable-based crops

In areas with high population, density and strong market demand located the nearest city center; farmers tend to grow crops with fast growth, such as vegetables. This wetland typology is largely confined to wetlands adjacent to the city center and accounts for about 20.998 ha or 6.20% of wetlands, which is dynamically converted to other land uses.

Based on land conversion typology, it is divided into two typology items, i.e. the first typology tends to show with high conversion. That happens on agricultural land that has been equipped with adequate infrastructure and generally has excellent accessibility. The second typology with a tendency to decrease land conversion generally occurs in areas with poor accessibility, inadequate infrastructure, and remote areas located away from settlements and housing.

3.3. Why Do Farmers Grow Wetlands Rice?

Ricefield is an agricultural land having a function as a place to grow rice. This shows that the agricultural world is closely related to human welfare as Kiggundu II et al (2018) in Uganda reported it. Farmers have struggled to cultivate rice in order to produce rice as their staple food. Although rice has a low yield and requires high labor intensity, farmers continue to grow rice as their primary livelihood. The results of the field survey illustrated that various reasons why farmers grow rice on wetlands can be summarized in Table 3.

Table 3. Contributing determinant factors why farmers grow wetlands rice

Nr	Contributing factors	Percentage (%)
1.	Technical Aspects	31.89
	Governmental support (7.05 %) */	
	Short rice age (4.95%)	
2.	Economic Aspects	44.86
	Avoiding the famine months (10.23%)	
	Low opportunity cost of labor and land (9.18%) **/	

3. Environmental Aspects	23.25	Land resource base (11.79%)	
Preference of ethnic minorities (5.68%)			
Quality and suitability to alternative use (5.78%)			Total
	100.00		

Note: */ Helping *saprotan* (means of agricultural production)

**/ other landuses in both agriculture and other sectors. Source: Primarily survey results (2019).

3.3.1 Technical Aspects

Technical aspects include soft skill components of farmers (contributing around 19.89%); Governmental support (participating about 7.05%); and short rice age (giving a part of 4.95%). It totally contributed around 31.89%. The existence of this soft skill will facilitate them in cultivating rice, so they are able to manage the water availability and water needs in accordance with the needs of the period of plant growth. In the farming process, farmers having enough soft skill said that it is easy to do rice farming, thus rice cultivation will further accelerate rice harvest when compared to planting other crops.

The Government generally implements governmental support in a programmed and systematically measured manner (contributing about 7.05%). This illustrates that the Governmental support is less contributing to farmers to grow rice, although the Banyuasin government is intent on maintaining Banyuasin as a national food barn, therefore the Banyuasin government provides assistance to the farmers to keep the rice production. Support from the government technically has triggered the spirit of farmers to keep doing rice production on wetlands. In terms of rice, age to harvest period is relatively short compared to other annual crops (only contributing around 4.95%), so farmers do not have to wait long until rice can be harvested. Generally, rice wetlands are less than four months and farmers are able to grow rice more than twice a year, as long as irrigation and drainage conditions can be managed.

3.3.2 Economic Aspects

The economic aspect belongs to dominant factor of reasons of farmers and consists of price risk; avoiding the famine months; and low opportunity cost of labor and land that contributed 44.86%. Price risk plays quite high role, i.e. 25.45%. Dependence on market-based strategies to meet the food needs of farmers can expose farmers to dangerous levels of risk and difficult to accept if rice prices are unstable. To avoid the risk of fluctuating rice prices is one of the main reasons why farmers do rice production subsistent, and to produce quality rice as a carbohydrate-rich staple food. In addition, food markets tend to be efficient due to high transportation costs and low agricultural productivity. Therefore, rice production in most agricultural land in remote locations is a strategy to protect this price risk.

The vulnerable areas to poverty are located in the remote locations and have poor marketing infrastructure, so that local people are unable to engage in any activity to participate and to gain benefit from broader economic growth. Most wetlands have the characteristics of poverty

as mentioned above. Wetlands rural communities suffer from poverty and food insecurity, especially if their condition are less accessible and isolated, the more isolated a wetlands region is located, the more widespread and poverty is found.

For example, on wetlands where inadequate public infrastructure (e.g. drainage and water gates system, infrastructure, poor market and bad road conditions) was found that poverty rates reached around 37-57%, which was higher than the average level of the national condition (only 20-25%). In these isolated areas, rice production is usually not sufficient to meet the consumption needs of almost 25% of households living in isolated areas, despite the fact that Banyuasin belongs to a national food barn (center). Conditions like this need to get serious attention from the government.

Avoiding the famine months (hungry months) plays a role in decision making farmers to grow rice and contribute about 10.23%. At a time when the drought especially in the dry season has caused the food supply to decrease, the debt increases, the assets are sold, and most household members do work diversification or migrate. However, most rice fields are usually harvested around in September. Some farmers belong to socially marginalized ethnic minorities and are trapped in a poverty cycle. There are two main things that strengthen and preserve poverty, namely the degradation of environmental resources (outside cycle) and food insecurity (inner cycle). The outside cycle (the degradation of environmental resources) was triggered by an increase in the number of people who caused increased pressure on land resources. The more intensive the wetlands are cultivated without being followed by adequate technology applications, the more demanding the appropriate technology is to preserve it, if it is not done. The second cycle (inner cycle) can be identified as a result of the lack of opportunity to participate in getting income. This is because farmers have less access to markets and their houses are located in remote areas with poor infrastructure. Farmers use most of their land and labor resources just to meet food needs by practicing subsistence agriculture. As a result, they have few resources left to take advantage of limited productive income opportunities. Mugisha et al (2017) found some factors enhancing household nutrition in South-Western Uganda and showed looks like phenomena. Low opportunity cost of labor and land plays an important role and contributed about 9.18% in determining the opinion of farmers. On wetlands with low access to markets, the cost of family employment is likely to be low due to limited employment (agriculture or nonagricultural employment).

The importance of rice may change as the cost of land and labor opportunities increases due to growing market interconnections. However, as mentioned in the previous section, wetlands rice fields have remained more or less stable over the last few decades. Environmental aspects are explained in terms of land resource base (contributing around 11.79%); preference of ethnic minorities (participating around 5.68%); and quality and suitability to alternative uses (giving 5.78%). It was totally contributing about 23.25%. The location of geographically strategic land resources to grow rice is profitable for farmers to do rice farming. Land resource environmental conditions belong to wetlands and many swamps, so that irrigation and drainage systems are very likely to be applied to rice farming and cultivation. Rice fields are the main reservoir of wetlands farmers. For example, wetlands account for 73% of agriculture and contribute to more than half the supply of household rice. Rice production on wetlands is part of the livelihood system of farmers, especially for those with very limited access to irrigated land. Farmers who have large irrigation fields tend to plant some rice fields. An important factor is the spread of labor usage. Rice fields are usually formed from intensive farming systems in labor and model and are harvested early, so as to spread longer labor usage and avoid labor bottlenecks.

Preference of ethnic minorities contributed around 5.68% of contributing determinant factors why farmers grow wetlands rice. Rice production is a way of life for many ethnic minority groups inhabiting wetlands, especially the Javanese. Even in a highly commercialized and market-oriented production system, these ethnic minorities still continue to grow rice. Quality and suitability to alternative use contribute around 5.78%. Traditional rice varieties of rice are believed to be higher than rice in many cultures. Even farmers who have a sufficient number of rice still produce some rice for quality. For commercial farmers, this can also provide a premium price in the market, even though yields are lower. In addition, rice is believed to be more suitable for certain uses such as for festivals and for making special products such as rice cakes, rice shakes, rice wine and any others.

3.4 Critical Entry Points for Food Security and Poverty Reduction

Food insecurity and poverty is characterized by the conditions of poor and powerlessness experienced by farmers, both due to the inability to meet the needs of life, as well as the inability of the state or society to provide social protection to farmers. There are several criteria indicating food insecurity and poverty, which are as follows: inability to meet basic consumption needs (food, clothing, and housing); social disadvantage (abandoned children, women victims of domestic violence, poor widows, marginalized and remote groups); the low quality of human resources (illiteracy, low education and skills, sickness); limited natural resources (infertile soil, remote location, lack of road infrastructure, electricity, water and others); and lack of access to adequate and sustainable employment and livelihoods.

By using broader perspectives, determinant factors of food insecurity and poverty causes can be described as follows: low productivity of wetlands; uneven development; consequential poverty; and social and problem management. Low productivity of wetlands contributes the most dominant to food insecurity and poverty on wetlands (contributing around 53.77%). The main factor why farmers are difficult to farm in wetlands is inadequate water management and limited infrastructure in regulating water regulation. This is commonly dominated by bio geophysical factors of wetlands that are beyond the ability of farmers to solve this problem because it is global, macro, and comprehensive.

Uneven development is related to government contribution in executing development (this factor plays a role of about 28.45%). This subsistence poverty is caused by low development or uneven development, rural poverty (poverty due to rural marginalization in the development process), urban poverty (poverty caused by the essence and speed of urban growth). Consequential poverty is poverty caused by natural occurrences or external factors outside the poor, such as conflict, natural disasters, environmental degradation, and high population. Consequential poverty only contributes slightly, around 9.21%. Social and problem management is a minority factor in determining poverty and contributes only about 8.57%. As an example of poverty experienced by women, children and minorities due to their unfavorable social conditions, such as gender bias, discrimination or economic exploitation. Improving rice productivity as a result of these changes also encourages the cultivation of cash by relaxing the food security constraints at the household level. With their food needs increasingly met from their own production, farmers are looking for opportunities to generate cash income by producing various crops for the market. This strategy also gives environmental dividend because some land previously used for agricultural production can be fired for forest plantations. Increased food productivity helps to take some of the marginal land from production.

CONCLUSIONS

From the results and discussion of this research, it can conclude some important items as follows: Plants grown on wetlands vary greatly, such as rice, corn, soybeans, sweet potatoes, nuts, and cassava. Although the cultivated commodity diversity on wetlands is quite high, but the most of wetlands settled in by poor farmers, they seek food farming in order to meet their own subsistence with little agricultural input, making it relatively difficult for crops to be able to produce optimally. Based on market access and population density, thus typology of agricultural land uses on wetlands in Banyuasin district classified as subsistence-based; cash crop-based; continuous rice-based; extensive perennial-based crops; and vegetable-based crops. The main typology was dominated by continuous rice-based system taking around 197.961 ha or 58.50% and the lowest level was shown by vegetable-based crops around 20.998 ha or 6.20%.

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