International Journal of Sustainable Development and Planning
Vol. 18, No. 4, April, 2023, pp. 1179-1186
Journal homepage: http://iieta.org/journals/ijsdp

Overcoming Degradation and Increasing the Value of Peatland Benefits Through the Cultivation of Pineapple in Riau Province, Indonesia

Djaimi Bakce[1*], Syaiful Hadi[2], Jum'arti Yusri[2], Krismon Dedi Saputra Sinaga[2]

[1] Center for Agricultural and Rural Development Studies, Riau University, Pekanbaru 28293, Indonesia
[2] Department of Agribusiness, Agricultural Faculty, Riau University, Pekanbaru 28293, Indonesia

Corresponding Author Email: djaimi.bakce@lecturer.unri.ac.id

https://doi.org/10.18280/ijsdp.180422

Received: 25 November 2022
Accepted: 14 February 2023

Keywords:
peatland, restoration, pineapple, good agricultural practices

ABSTRACT

Peatland restoration can be done by re-greening, but it takes a long time. Therefore, planting more productive and short-lived crops on burnt peatlands could be a good alternative solution. Restoration of damaged peatlands can be done by cultivating pineapples by applying good agricultural practices. The results of the research we conducted in Riau Province using a gap analysis showed that most farmers in Riau Province had implemented good pineapple cultivation methods from the aspects of seed selection, land preparation, planting and harvesting. However, the application of good agricultural practices is still weak from the aspect of plant maintenance, including fertilizing, weeding, thinning and watering. The lack of knowledge of good pineapple cultivation techniques and limited capital on the one hand, the high price of fertilizer on the other hand means that the maintenance of pineapple plants cannot be carried out optimally. Based on the results of the income analysis, it can be said that the income derived from pineapple farming is greater than that of oil palm farming carried out by independent smallholders on peatlands. Through training, capital assistance, and continuous assistance, it is believed that it will provide optimal results so that it can overcome, at least reduce, the problem of degradation and increase the beneficial value of peatlands. Further research is planned to obtain a more comprehensive and accurate description of the potential commodities to be developed on peatlands. In 2023 the focus will be on coconut and sago commodities, and in 2024 the focus will be on palm oil and rubber commodities.

1. INTRODUCTION

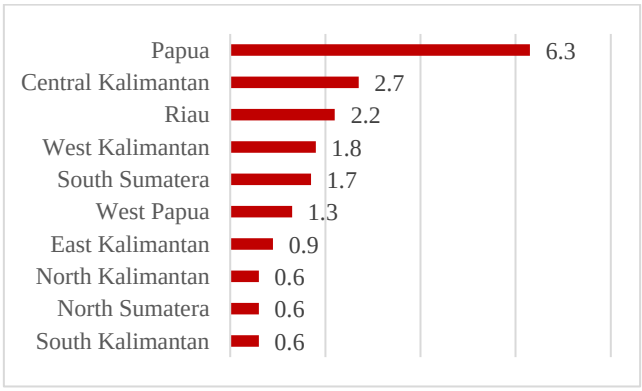
Wetlands can be defined as land where the soil is waterlogged due to the condition of the soil being saturated with water either permanently or seasonally. These puddles can usually be flowing or still water [1]. According to Elsworth [2] wetland is the collective name for all areas outside the oceans that are permanently or periodically covered with water.

Peatlands are wetlands with a watery soil layer composed of dead and decaying plant matter. The total area of peatlands accounts for half of the area of wetlands in the world. All peatlands can be found in different parts of the world. As quoted from the Wetlands International article [3], the functions of peatlands are, among others: water storage, peatlands can absorb rainwater, prevent flooding, release water slowly, and guarantee a supply of clean water throughout the year. As a source of food, millions of people depend on peatlands as areas for herding cattle, fishing and carrying out agricultural activities. Breeding of Species, tropical peat swamp forests are home to thousands of animals and plants, including rare and endangered species such as the orangutan and Sumatran tiger. Climate change, peatlands contain twice as much carbon as existing forests worldwide. When disturbed or drained, peatlands can be a major source of greenhouse gas emissions.

Based on the above definition, in conditions in the field, land that is permanently or periodically covered with water can be in the form of peatlands, swamps, and ecosystems around watersheds. Wetlands have a main function as a water catchment area, besides that many have also been used for fisheries and agriculture. According to Monteverde et al. [4] the use of wetlands, including peatlands, for agriculture faces a dilemma, on the one hand peatlands are needed to meet food needs and security, bioenergy development, and economic growth, especially the development of export commodities. On the other hand, Indonesia is committed to reducing greenhouse gas emissions in accordance with Presidential Regulation of the Republic of Indonesia Number 61 of 2011, among others, not to clear forests and peatlands. Meanwhile, the availability of potential land from mineral land is increasingly limited due to high competition and competition for land use and conflicts of interest for various sectors. According to Masganti et al. [5] of 14.9 million hectares of peatland, around 3.74 million hectares is degraded land, both in forest areas and in agricultural cultivation areas.

Meanwhile, based on global wetland data in 2019, Indonesia has a peatland ecosystem with an area of 22.5 million ha. Riau Province has a peatland area of 2.2 million ha after Papua Province (6.3 million ha), and Central Kalimantan Province (2.7 million ha). This is followed by West Kalimantan (1.8 million ha), South Sumatra (1.7 million ha), West Papua (1.3 million ha), East Kalimantan (0.9 million ha), and North Kalimantan, North Sumatra and South Kalimantan

possess 0.6 million ha each [6]. The 10 provinces with the largest peatlands in Indonesia can be seen in the following Figure 1.



Source: Katadata, [6]

Figure 1. The 10 provinces with the largest peatlands in Indonesia (million ha)

Apart from being unproductive, degraded peatlands are also a source of greenhouse gas emissions and if left unchecked, degradation may continue or return to forest, but this will take a very long time. For this reason, it is necessary to formulate directions and policies that refer to several perspectives [7-11]. The Indonesia government through the Ministry of Environment and Forestry by issuing Government Regulation Number 71 of 2014 with the aim of controlling damage to peat ecosystems is carried out based on the national, provincial and district/city peat ecosystem protection and management plans as referred to in Article 16 paragraph (2) controlling peat ecosystem damage consists of: a. prevention of peat ecosystem damage; b. prevention of peat ecosystem damage; and c. restoration of damaged peat ecosystems with several criteria: (i) the main basis for peatland utilization is saving natural resources and the environment, as well as to support food security, environment-based community self-reliance, (ii) the main priority for management is carried out by and for the community/farmers in the context of agrarian reform to support increasing the welfare of farmers, and must be managed based on the principles of environmentally friendly and sustainable agriculture and/or a system of intensification of sustainable agriculture with minimum ecological risk, (iii) common perception of all policy makers and stakeholders, and (iv) taking into account conditions utilization of existing peat (policies, functions, spatial and territorial plans, land cover, permits, moratorium, fires and damage), problems and strategic issues that arise, and the need for sustainable management of peat, it is necessary to formulate directions, policies and strategies for peat ecosystem utilization in the future.

As stated by the researchers above, apart from being unproductive, degraded peatlands are also a source of greenhouse gas emissions and if left unchecked, degradation may continue or return to forest, but it will take a very long time. Along with the decreasing and limited fertile mineral land because it is used for the development of various sectors, and the increasingly limited land for agriculture, causing people to use wetlands for agricultural and other businesses.

Soil types in Riau Province are dominated by organosol soil types. Organosol soil is organic soil originating from peat and swamps, its distribution reaches 50% of the area of Riau, especially in the lowlands and coastal areas [12]. In Riau Province, wetlands have long been used for the cultivation of various types of plants, both food, horticultural and plantation crops. Even though it is stated that wetlands, including peatlands, are included in marginal lands or sub-optimal lands, the cultivation of these various plants is still profitable and is the main source of livelihood for the community. The group of food crops that are widely cultivated by the people of Riau Province in wetlands include rice and corn. Horticultural plant groups include various types of pineapple plants, other fruits and vegetables, pineapples and other fruits. Furthermore, plantation crops that are widely cultivated include oil palm, rubber, coffee, sago and areca nut. In order to realize food security in Riau Province on the one hand, inhibit and overcome the problem of degradation of wetlands on the other hand, it is necessary to formulate an optimal and efficient strategy for the development of potential agricultural commodities in wetland areas, especially in peatlands.

One of the potential agricultural commodities and has been widely developed in the peatlands of Riau Province is pineapple. The results of CIFOR's research [13] show that pineapple is a productive, profitable and peat-friendly commodity. Pineapple cultivation on peatlands is best done with agroforestry patterns and best practices in land preparation, seeding, planting, and strengthening various types of capital, such as social capital, human capital, and financial capital.

This study aims to determine the technical cultivation of potential agricultural commodities that are applied and compare them with good agricultural practices. Besides conducting a gap analysis between the application of cultivation techniques carried out by farmers with reference to good agricultural practices, an analysis of pineapple farming income was also carried out. The results of the pineapple farming income analysis were then compared with the analysis of smallholder oil palm farming on peatlands.

2. RESEARCH METHOD

This paper is part of the research results of the first year of a three-year research plan to be carried out with the title Development of a Potential Agricultural Commodity Optimization and Economic Efficiency Model in the Wetland Region of Riau Province. Research in the first year (2022) is directed at formulating a Model Development for Optimization and Economic Efficiency of Potential Agricultural Commodities in the Wetland Area of Riau Province which focuses on pineapple commodities and their derivative products in three districts, namely: in Kampar Regency, Siak Regency, and Bengkalis Regency. Funding in this research was supported by the University of Riau through the Riau University Budget Implementation List for 2022 in the Higher Education Excellence Basic Research (PDUPT) scheme grant for the 2022-2024 fiscal year, contract number 1364/UN.19.5.1.3/PT.01.03/2022. In the second year (2023), focus on coconut and sago commodities. Then in the third year (2024), our research will focus on palm oil and rubber commodities. The second year of research has been approved for funding by the University of Riau through the Riau University Budget Implementation List for 2023 in the Higher Education Excellence Basic Research (PDUPT) scheme grant for the 2022-2024 fiscal year, contract number 6474/UN.19.5.1.3/ AL. 04/2023.

This paper uses two analytical techniques, namely gap analysis and income analysis. Gap analysis is very popular and

is widely used by experts and researchers to see the level of achievement in the implementation of cultivation of an agricultural commodity with applicable cultivation standards. Burning issues related to Good Agricultural Practices (GAP) in the commodity of palm oil, for example, require the fulfillment of all principles and criteria of the Roundtable on Sustainable Palm Oil (RSPO) or Indonesia Sustainable Palm Oil (ISPO) for large business actors and small farmers [14]. Likewise, FAO published a scheme and training manual on Good Agricultural Practices (GAP) for fruits and vegetables in order to improve the performance of fruit and vegetable farming. In evaluating the performance achievements of the cultivation of agricultural commodities, the gap analysis method is widely applied [15].

To obtain more convincing results that pineapple is a potential commodity that needs to be developed on peatlands, the net revenue/profit/income analysis is used. In various references to the science of farming and the economics of agricultural production, one of the most popular performance measures is income analysis [16, 17]. The results of the income analysis of pineapple farming are then compared with the results of the income analysis of independent smallholder oil palm farming on peatlands from various references to previous studies. This is done with the consideration that oil palm cultivation is mostly carried out by farmers on peatlands. As previously explained, this paper is part of research planned to be carried out for 3 years, in which the analysis related to palm oil commodities will be carried out directly by researchers in the third year (2024).

Gap analysis was carried out by comparing pineapple cultivation techniques used by pineapple farmers with guidelines for pineapple cultivation techniques that refer to good agricultural practices compiled by the Center for International Forestry Research (CIFOR) in 2019. The gap analysis covers all stages in pineapple cultivation, namely: seed selection, land preparation and planting, plant maintenance (fertilizing, weeding, thinning, and watering), and harvesting. For each stage and sub-stage of pineapple cultivation activities, the percentage of conformity between the application of pineapple cultivation techniques by farmers and the guidance documents prepared by CIFOR is explained.

The net revenue/profit/income analysis refers to David and Fischer [16], the profit gained by an individual is equal to the difference of gross margin and fixed cost, while the gross margin is referred to as the total revenue minus the total cost experienced on variable inputs. It can also be defined as the total market value of the output produced minus the total cost experienced in a production process Debertin [17] given by the following formula:

$$\pi = TR - TC \quad (1)$$

$$TR = PQ_i \times Q_i \quad (2)$$

$$TC = Px_i \times X_i \quad (3)$$

where, π is the net revenue gained minus total costs or simply the profit; TR is the total or gross revenue gained from the output; TC shows the amount of cost incurred; PQ is the price per unit of output; Q_i shows the total amount of output produced; Px_i is the price per unit of input; and X_i shows the inputs' quantity.

3. RESULT AND DISCUSSION

3.1 Level of implementation of good agricultural practices

As explained in the methodology section, to determine the condition of the economic efficiency of potential commodities, two analytical approaches are used, namely: analysis of cultivation techniques and analysis of production efficiency. Cultivation technique analysis was carried out using descriptive analysis through gap analysis between the cultivation techniques applied by farmers and good agricultural practices. Gap analysis from the cultivation technique aspect was carried out by comparing the pineapple cultivation technique according to the reference with that applied by the farmers. The reference for pineapple cultivation techniques refers to the Guide to Pineapple Cultivation in Peatlands written by Puspitaloka et al. [18] from the Center for International Forestry Research (CIFOR). The results of the analysis of the suitability of the application of pineapple cultivation techniques by farmers with references are presented in the following Table 1.

Table 1. Percentage of conformity of pineapple cultivation technique application by farmers with CIFOR's cultivation techniques

Stages of Pineapple Cultivation Technique According to CIFOR's	Percentage of App Fit by Farmers	Information
		A. Selection of seeds
Seedlings can be in the form of crowns, stem shoots, and root shoots	100,00%	Farmers generally use seeds from root shoots and stems, no one uses seeds from crowns
Seeds are uniform or come from one type	100,00%	All farmers who were observed and interviewed used Moris seeds.
		B. Land preparation
Land is cut down	100,00%	All farmers observed and interviewed were farmers who had cultivated pineapples on the same land several times. Preparation is done by slashing or chopping the harvested pineapple plants to be planted with new pineapple plants.
Spray with herbicide	100,00%	After slashing or chopping, the land is sprayed with herbicide 1-2 times. Most of the farmers sprayed the herbicide twice. The herbicides used were systemic and contact herbicides.
		C. Planting
One-row or two-row cropping pattern	95,35%	There are a small number of farmers who plant more than 2 rows and/or irregularly.
Distance between pineapples 35-50 cm	56,98%	There are a small number of farmers who plant more than 2 rows and/or irregularly.

Stages of Pineapple Cultivation Technique According to CIFOR's	Percentage of App Fit by Farmers	Information
The distance between the lanes is 80-100 cm	61,63%	There are a number of farmers who apply distances between lanes of less than 80 cm (only 70 cm) and more than 100 cm (up to 150 cm).
The depth of the planting hole is 5-10 cm	87,21%	There are a small number of farmers who apply a planting hole depth of > 10 cm.
		D. Hoarding
Stockpile soil around the base of the stem to strengthen it	90,70%	There are a small number of farmers who do not stockpile
		E. Fertilization
First Fertilizer (Basic)	0,00%	
Fertilization time after planting	0,00%	All farmers do not fertilize with basic fertilizers (manure)
Manure with a dose of 10 tons/ha	0,00%	
The first follow-up fertilizer		
Fertilization time 2-3 months after planting	9,30%	Most farmers do not apply the first follow-up fertilization or apply fertilizers sooner than 2 months or longer than 3 months
Urea at a dose of 300 kg/ha	9,30%	Most of the farmers apply the Urea dose used is less than 300 kg/ha
CuS04 (terusi) at a dose of 5-10 kg/ha	10,47%	Most farmers apply CuSO4 doses less than 5 kg/ha
The second follow-up fertilizer		
Fertilization time 5-6 months after planting	12,79%	Most of the farmers do not do the second follow-up fertilization or fertilize sooner than 5 months or longer than 6 months
Urea at a dose of 300 kg/ha	9,30%	Most of the farmers apply the Urea dose used is less than 300 kg/ha
CuS04 (terusi) at a dose of 2-10 kg/ha	19,77%	Most farmers use CuSO4 doses less than 2 kg/ha
TSP with dosage as needed	100,00%	Only a small number of farmers use TSP fertilizer
KCl with dosage as needed	100,00%	Only a small number of farmers use KCl fertilizer
The third follow-up fertilizer		
Time 9-10 months after planting	0,00%	All farmers do not apply the third follow-up fertilization or fertilize sooner than 9 months or longer than 10 months
Ethrel at a dose of 150 ml/ha	8,14%	Most farmers use Ethrel, but with doses less than 150 ml/ha
Urea at a dose of 100 kg/ha	8,14%	Most of the farmers apply the Urea dose used is less than 100 kg/ha
The last follow-up fertilizer		
Time 11-12 months after planting (marked by the release of the pistil / pineapple)	0,00%	All farmers do not apply the last follow-up fertilization or fertilize sooner than 11 months or longer than 12 months
Urea at a dose of 250 kg/ha	0,00%	All farmers did not apply the last supplementary fertilizer or applied a dose of Urea less than 250 kg/ha
CuS04 (terusi) at a dose of 5 kg/ha	0,00%	All farmers did not apply the last supplementary fertilizer or applied a dose of CuSO4 that was used less than 5 kg/ha
KCL with a dose of 250 kg/ha	0,00%	All farmers do not fertilize the last supplementary fertilizer or apply a KCl dose that is used less than 250 kg/ha
		F. Thinning
Each clump maximum number of tillers is 2 tillers	0,00%	All farmers do not do thinning
		G. Weeding
Weeding can be done 2-4 times during the planting period together with thinning	62,79%	Some farmers do not do thinning or do thinning only once during the planting period
		H. Sprinkling/watering
At least once a week, especially in the dry season	0,00%	All farmers do not do watering
Adult plants once every 2 weeks	0,00%	
		I. Harvesting
The characteristics of pineapples that are ready to harvest:		All farmers understand and apply harvesting according to the characteristics of pineapples that are ready to harvest.
Pineapple crown is more open,	100,00%	
The fruit stalk is wrinkled,	100,00%	
Pineapple eyes are flatter and rounder in shape,	100,00%	
Skin color at the base of the fruit begins to turn yellow,	100,00%	
The smell of pineapple started to appear.	100,00%	
Harvest Time:		
Stem shoots: 18 months	100,00%	
Puppies: 15-18 months	100,00%	
Crown: 24 months	100,00%	

Source: Puspitaloka et al. [18] from the Center for International Forestry Research (CIFOR), and results of survey data analysis.

Based on the results of the analysis presented in the table above, it can be stated that most farmers in Riau Province had implemented good agricultural practices for pineapple cultivation from the aspects of seed selection, land preparation, planting, and harvesting. The application of good agricultural practices is still weak from the aspect of plant maintenance, including fertilization, weeding, thinning and watering. In general, pineapple farmers do not do weeding, thinning and fertilizing. Although most of the farmers do fertilization, the dosage is still far below the recommendation. The low knowledge of good pineapple cultivation techniques and limited capital on the one

hand, the high price of fertilizer on the other hand, causes pineapple plant maintenance to have not been carried out optimally.

3.2 Income earnings

Farm income analysis is carried out using an economic approach, not an accounting approach. This implies that all activities and costs incurred in pineapple farming are calculated as costs including the cost of one's own input, namely the cost of labor in the family and the cost of depreciation of the agricultural tools and machinery used.

Income is the difference between revenue and total costs incurred in conducting pineapple farming starting from land preparation to harvesting. Revenue is the product of production and the price of pineapples. The total cost of production is the sum of the costs of production inputs, costs of farming activities, depreciation costs and other costs. Revenue and total production costs (including components) are calculated per production process, where one production process lasts for 18 months. From the calculation of income per hectare per production process, then income per hectare per month is calculated. The results of the analysis of pineapple farming income per hectare in Riau Province are presented in the following table (Table 2).

Table 2. Analysis of pineapple farming income per hectare in Riau Province

Description	Amount	Price (IDR)	Value (IDR)
A. Revenue			85.625.476,19
1. Production (fruit)	24.294,00		
2. Production (kg)	17.125,10	5.000,00	
B. Costs of seeds, fertilizers, fruit stimulants, and herbicides			10.398.987,78
1. Seeds (stems)	25.663,00	300,00	7.698.900,00
2. Urea/ZA Fertilizer (kg)	335,80	3.000,00	1.007.400,00
3. CuSO4 Fertilizer (kg)	6,40	35.000,00	224.046,67
4. KCl Fertilizer (kg)	34,22	12.000,00	410.666,67
5. Ethrel (ml)	256,47	450,00	115.410,00
6. Herbicide (l)	6,50	145.000,00	942.564,44
C. Farm Activity Costs			27.206.900,87
1. Collection of seeds (stems)	25.663,00	100,00	2.566.300,00
2. Chop and Slash (workman's day)	17,26		3.451.090,17
Wages (IDR/ workman's day)		200.000,00	
3. Herbicide Spraying (workman's day)	2,75		577.714,29
Wages (IDR/ workman's day)		210.000,00	
4. Planting (stems)	25.663,00	300,00	7.698.900,00
5. Fertilization (workman's day)	10,74		1.074.095,24
Wages (IDR/ workman's day)		100.000,00	
6. Weeding (workman's day)	32,43		3.242.857,14
Wages (IDR/workman's day)		100.000,00	
7. Hoarding (workman's day)	13,08		1.307.744,03
Wages (IDR/ workman's day)		100.000,00	
8. Harvesting (IDR/fruit)	24.294,00	300,00	7.288.200,00
D. Cost of depreciation (IDR/ha)			798.678,89
E. Miscellaneous expense (IDR/ha)			398.431,64
F. Total cost (B+C+D+E)			38.802.999,17
G. Income per Ha per Production Process (A-E)			46.822.477,02
H. Income per Hectare per Month			2.601.248,72

Source: Results of survey data analysis
Note: the length of time per production process of pineapple farming is 18 months, and one working day is 8 hours.

From the table, it can be seen that the amount of pineapple production produced by farmers in Riau Province is an average of 24,294.00 fruit per ha, or equivalent to 17,125.10 kg/ha. The price of pineapple in Riau Province varies between IDR 4,200/kg - IDR 7,500/kg, with a mode value of IDR 5,000/kg. By using the price based on the mode value, the pineapple farming revenue in Riau Province is IDR 85,625,476.19 per ha per production process.

The total production cost of pineapple farming is IDR 46,822,477.02 per ha per production process. These costs consist of costs of production facilities, costs of farming activities, depreciation costs and other costs, respectively per ha per production process of IDR 10,398,987.78, IDR 27,206,900.87, IDR 798,678.89, and IDR 398,431.64.

By subtracting the revenue from the total production cost, the pineapple farming income per ha per production process is IDR 46,822,477.02. If converted per month, the income from pineapple farming per ha per month is IDR 2,601,248.72.

From various previous research results, information is obtained that the income of oil palm farming on peatlands per hectare per month is less than IDR 2,500,000 [19-25]. Thus, it can be stated that pineapple farming is more economically promising for the community compared to smallholder oil palm farming on peatlands.

As additional information, the results of our research show that if pineapple is processed into various processed pineapple products by household businesses, such as pineapple chips, pineapple dodol, pineapple diamonds and pineapple jam, it can generate an additional income of IDR 3,029,354 per month. Meanwhile, independent oil palm smallholders in Riau Province fully sell palm oil products in the form of fresh fruit bunches. In other words, if there is excess production of pineapple, it can be used to be processed into various processed products that are more economically valuable and durable. Meanwhile, it is recommended that fresh fruit bunches of oil palm be processed into crude palm oil (CPO) and kernels not exceeding the 48 hours limit, in fact it is hoped that it will take less than 6 hours.

3.3 Strategies to overcome degradation and increase the benefit value of peatlands through the development of pineapple cultivation

From the results of the analysis, it can be stated that the profits obtained from pineapple farming carried out by farmers are quite large. On average, the profitability of pineapple farming in Riau Province exceeds that of oil palm farming on peatlands. However, pineapple farming carried out by small farmers in Riau Province is still faced with the problem of not fully implementing the principles of good agricultural practices so that the farming carried out by most farmers is inefficient so that the resulting production is not optimal and the profits are not maximized.

Some of the problems and constraints from the aspect of implementing good agricultural practices as discussed in the previous section are:

(1) The planting system, spacing of pineapples between rows, within rows and between lanes is still not in accordance with recommendations. This causes the distance between plants and between lines that are too close or too far. Spacing that is too close causes the amount of pineapple production produced is still below standard. Planting spacing that is too close causes competition for nutrients and sunlight so that the production of pineapples is large but small. On the other hand, spacing that is too far causes the amount of production to be small even though the size of the pineapples produced is large.

(2) The length, width, and depth of the planting holes used by farmers also vary, many of which are not up to standard. This also affects the development of pineapple plants, so that the resulting pineapple production is still below standard.

(3) Fertilizers used by farmers also vary and have not yet applied the six principles of farming: right time, right dose, right place, right type, right amount, and right price. Fertilization time that is too fast and too late will affect plant growth. Too little or too much fertilizer inhibits plant growth. Not all types of fertilizer that are recommended are used by farmers, for example pineapple farmers in Kampar generally do not use CuSo4 (terusi). The availability of different amounts, types and prices of fertilizers in each district also affects the fulfillment of fertilization compared to good pineapple cultivation standards. The absence of recommendations for locality-specific cultivation techniques also causes various applications of fertilization by farmers.

(4) None of the farmers in the three districts that were the focus of research in Riau Province did watering, even though for good pineapple growth, sufficient water was needed. Watering should be done especially in the dry season.

(5) Marketing of pineapples is generally done by selling pineapples to traders who come to buy pineapples directly to farmers. Pineapple prices are set by traders. Most of the pineapples are bought by traders from Pekanbaru City. It can be informed that the price of pineapple at the time of the survey was IDR 7,500/kg in Kampar Regency, IDR 5,000/kg-IDR 6,000/kg in Siak Regency, and IDR 4,000-IDR 4,500/kg in Bengkalis Regency. Traders sell pineapples in Pekanbaru City at a price of IDR 10,000/kg - IDR 12,000/kg.

Observing these various problems, in order to produce optimal production and maximum profit, several strategies need to be implemented, namely:

(1) Develop research and development (R&D) of locality-specific pineapple cultivation technology on peatlands, according to the characteristics and thickness of the peatlands.

(2) Conducting counseling through training and assistance in the application of good agricultural practices to farmers in intensive and continuous pineapple farming.

(3) Providing subsidized fertilizer assistance to pineapple farmers.

(4) Provide assistance and support for the expansion of the pineapple market between islands and between provinces.

(5) Develop and strengthen pineapple farmer groups and cooperatives.

Farm income analysis is carried out using an economic approach, not an accounting approach. This implies that all activities and costs incurred in pineapple farming are calculated as costs including the cost of one's own input, namely the cost of labor in the family and the cost of depreciation of the agricultural tools and machinery used.

The Government of the Republic of Indonesia has a strong commitment to preventing environmental damage, especially on peatlands. Through the Peat Restoration Agency of the Ministry of Environment and Forestry of the Republic of Indonesia, systematically and continuously strives to prevent forest and land fires as well as manage and control peat ecosystems. Peat ecosystem management is carried out, among other things, by developing various types of potential commodities from economic and environmental aspects [26-28].

In the context of managing and controlling peat ecosystems, it is necessary to involve various stakeholders, both government and non-government, namely involving local and international communities, companies, universities and non-governmental organizations. This needs to be done so that planning, organizing, implementing, and supervising can be carried out properly and fairly [29-35].

6. CONCLUSIONS

In general, pineapple farmers apply pineapple cultivation techniques that are not in accordance with the principles of good farming practices. The application of the principles of good agricultural practices is only at the stage of land preparation and harvesting. While those that are not suitable are mainly related to: (1) the cropping system, the spacing of pineapples and pineapples between rows, within rows and between rows is still not as recommended; (2) The length, width and depth of the planting holes used by farmers also varied, many of which did not meet the standards; (3) Fertilizers used by farmers also vary and have not yet applied the six principles of farming, namely: right time, right measure, right place, right type, right amount, and right price; and (4) no farmers were found to water.

In order to produce pineapples with optimal production and maximum profits, so as to overcome the problem of degradation and increase in the value of peatlands, it is necessary to carry out several strategies, namely: (1) Conduct research and development (R&D) specific to the location of pineapple cultivation technology on peatlands in Indonesia, according to with the characteristics and thickness of peatlands; (2) Conduct counseling through training and mentoring the application of good farming methods in intensive and sustainable pineapple farming to farmers; (3) Providing subsidized fertilizer assistance to pineapple farmers; (4) Provide assistance and support for the expansion of the inter-island and inter-provincial pineapple market; and (5) Develop and strengthen farmer group institutions and pineapple farmer cooperatives.

In order to obtain an accurate and in-depth picture of the potential commodities on peatlands, we have planned to conduct research on various commodities currently being managed by the community on peatlands. In 2023, research will be focused on coconut and sago commodities. Then in 2024, our research will focus on palm oil and rubber commodities. The 2023 research has been approved for funding by the University of Riau through the 2023 Riau University Budget Execution List in a Higher Education Superior Basic Research (PDUPT) scheme grant for the 2022-2024 fiscal year, contract number 6474/UN. 19.5.1.3/ AL. 04/2023.

FUNDINGS

Thanks very much to the Institute of Research and Community Services (LPPM), Riau University. Contract number 1364/UN.19.5.1.3/PT.01.03/2022.

REFERENCES

[1] Bakce, D., Syahza, A., Suwondo, Wawan, Suprayogi, I., Sulaiman, R., Mustofa, R. Asmin, B. (2021). Perlindungan dan pengelolaan ekosistem gambut: kajian empirik lahan basah (wetlands). UR Press, Pekanbaru. https://www.researchgate.net/publication/354740632_Perlindungan_dan_Pengelolaan_Ekosistem_Gambut_Kajian_Empirik_Lahan_Basah_Wetlands_Center_of_Excellence_CoE_Universitas_Riau.

[2] Elsworth, S. (1990). A dictionary of the environment, a practical guide to todays most important environmental issues. Paladin Grafton Books, London, UK. https://wgbis.ces.iisc.ac.in/biodiversity/sdev/sus_enews/issue2/books2.htm.

[3] Wetlands International. (2021). Apa lahan basah itu? https://indonesia.wetlands.org/id/wetlands/apa-lahan-basah-itu/.

[4] Monteverde, S., Healy, M.G., O'Leary, D., Daly, E., Callery, O. (2022). Management and rehabilitation of peatlands: The role of water chemistry, hydrology, policy, and emerging monitoring methods to ensure informed decision making. Ecological Informatics, 101638. https://doi.org/10.1016/j.ecoinf.2022.101638

[5] Masganti, M., Riau, B.P.T.P., Marpoyan, P., Wahyunto, W., Dariah, A. (2014). Karakteristik dan potensi pemanfaatan lahan gambut terdegradasi di Provinsi Riau. Jurnal Sumberdaya Lahan, 8(1): 59-66. https://media.neliti.com/media/publications/133046-ID-cover-jsl-vol81-2014.pdf.

[6] Katadata. (2019). Luas gambut Indonesia terbesar kedua di dunia. https://katadata.co.id/infografik/2019/04/29/luas-gambut-indonesia-terbesar-kedua-di-dunia.

[7] Agus, F., Dariah, A., Jamil, A. (2013). Kontroversi pengembangan perkebunan sawit pada lahan gambut. Politik Pengembangan Pertanian Menghadapi Perubahan Iklim. Badan Penelitian dan Pengembangan Pertanian. Kementrian Pertanian. IAARD, Jakarta. Halaman, 454-473.

[8] Husnain, H., Agus, F., Wigena, I.P., Dariah, A., Marwanto, S. (2014). Peat CO_2 emissions from several land use types in Indonesia. Mitig Adap Strateg Glob Chang.

[9] Marwanto, S., Agus, F. (2014). Is CO_2 flux from oil palm plantations on peatland controlled by soil moisture and/or soil and air temperatures? Mitigation and Adaptation Strategies for Global Change, 19: 809-819. https://doi.org/10.1007/s11027-013-9518-3

[10] Maswar, M., van Noordwijk, M., Agus, F. (2013). Reducing emissions from peatlands (REPEAT). In: van Noordwijk M, Lusiana B, Leimona B, Dewi S, Wulandari D (eds) Negotiation-support toolkit for learning landscapes. World Agroforestry Centre (ICRAF) Southeast Asia Regional Program, pp. 148-152.

[11] Dariah, A., Marwanto, S., Agus, F. (2014). Root-and peat-based CO_2 emissions from oil palm plantations. Mitigation and Adaptation Strategies for Global Change, 19: 831-843. https://doi.org/10.1007/s11027-013-9515-6

[12] Bappedalitbang Riau Province. (2021). Perubahan Rencana Pembangunan Jangka Menengah Daerah (RPJMD) Provinsi Riau Tahun 2019-2024. Badan Perencanaan Pembangunan Daerah, Peneltian dan Pengambangan Provinsi Riau, Pekanbaru, Indonesia.

[13] Ilham, Q.P., Purnomo, H., Rohadi, D., Puspitaloka, D. (2019). Value chain analysis for haze-free livelihoods in peatlands. Working paper. CIFOR, Bogor, Indonesia.

[14] RSPO. (2022). RSPO free, prior and informed consent (FPIC) guide. https://rspo.org/wp-content/uploads/RSPO-Free-Prior-and-Informed-Consent-FPIC-Guide-2022_RSPO-GUI-T08-002-V2-ENG.pdf.

[15] FAO. (2016). A Scheme and training manual on good agricultural practices (GAP) for fruits and vegetables. Volume 1 the scheme -standard and implementation infrastructure. Food and Agriculture Organization of the United Nations, Regional Office for Asia and the Pacific, Bangkok. https://www.fao.org/3/i6677e/i6677e.pdf.

[16] David, B., Fischer, S. (2000). Economics. 6th ed.; British Library, Cataloguing in Publication Data, London, UK.

[17] Debertin, D.L. (2012). Agriculture Production Economics. 2nd ed. Macmillan Publishing Company, New York, USA.

[18] Puspitaloka, D., Hadi, S., dan Purnomo, H. (2019). Panduan budidaya nenas di lahan gambut. CIFOR, Bogor, Indonesia. https://www.cifor.org/publications/pdf_files/flyer/7329-Flyer.pdf.

[19] Gurusinga, A.U., Dewi, N., Rosnita, R. (2022). Analisis prospektif peremajaan kelapa sawit (Elaeis guineensis jacq) pola swadaya di kabupaten rokan hulu. Jurnal Sosial Ekonomi Pertanian, 18(1): 55-66. https://journal.unhas.ac.id/index.php/jsep/article/view/19024/7818.

[20] Bakce, D., Mustofa, R. (2021). Kesempatan kerja dan kelayakan ekonomi usaha perkebunan kelapa sawit rakyat di Kabupaten Indragiri Hulu. Jurnal Inovasi Penelitian, 2(7): 2213-2220. https://doi.org/10.47492/jip.v2i7.1064

[21] Gustina, Y., Chozin, M., Barchia, M.F. (2020). Analisis komparasi usahatani padi dan usahatani kelapa sawit (Studi Kasus di Desa Bukit Peninjauan II Kecamatan Sukaraja Kabupaten Seluma). Naturalis: Jurnal Penelitian Pengelolaan Sumber Daya Alam dan Lingkungan, 9(1): 67-76. https://ejournal.unib.ac.id/index.php/naturalis/article/view/12232.

[22] Naufal, M. (2019). Kinerja usahatani kelapa sawit lahan gambut di Desa Dayun Kabupaten Siak. Jurnal Tekno Sains, 9(1): 77-85. https://doi.org/10.22146/teknosains.38976

[23] Sari, D.A.P., Falatehan, A.F., Ramadhonah, R.Y. (2018). The social and economic impacts of peat Land palm oil plantation in Indonesia. Journal of Physics: Conference Series, 1364(2019): 012017. https://doi.org/10.1088/1742-6596/1364/1/012017

[24] Siradjuddin, I. (2016). Analisis serapan tenaga kerja dan pendapatan petani kelapa sawit di kabupaten pelalawan. Jurnal Agroteknologi, 6(2): 1-8. http://dx.doi.org/10.24014/ja.v6i2.2234

[25] Mustofa, R., Dewi, N., Yusri, J. (2016). Analisis komparasi usahatani kelapa sawit swadaya menurut tipologi lahan di Kabupaten Indragiri Hilir. Indonesian Journal of Agricultural Economics, 7(1): 47-55. http://ejournal.unri.ac.id/index.php/IJAE/article/view/3799.

[26] Syahza, A., Bakce, D., Irianti, M., Asmit, B., Nasrul, B. (2021). Development of superior plantation commodities based on sustainable development. International Journal of Sustainable Development and Planning, 16(4): 683-692. https://doi.org/10.18280/ijsdp.160408

[27] Syahza, A., Suwondo, Bakce, D., Nasrul, B., Mustofa, R. (2020). Utilization of peatlands based on local wisdom and community welfare in Riau Province, Indonesia. International Journal of Sustainable Development and Planning, 15(7): 1119-1126. https://doi.org/10.18280/ijsdp.150716

[28] Ramdani, R., Lounela A.K. (2020). Palm oil expansion in tropical peatland: distrust between advocacy and service environmental NGOs. Forest Policy and Economic, 118. https://doi.org/10.1016/j.forpol.2020.102242

[29] Syahza, A., Bakce, D., Irianti, M. (2019). Improved peatlands potential for agricultural purposes to support sustainable development in Bengkalis District, Riau Province, Indonesia. In Journal of Physics: Conference Series, 1351(1): 012114. http://doi.org/10.1088/1742-6596/1351/1/012114

[30] Syahza, A., Bakce, D., Asmit, B. (2018). Natural rubber institutional arrangement in efforts to accelerate rural economic development in the province of Riau. International Journal of Law and Management, 60(6): 1509-1521. https://doi.org/10.1108/IJLMA-10-2017-0257

[31] Uda, S.K., Hein, L., Sumarga, E. (2017). Towards sustainable management of Indonesian tropical peatlands. Wetlands Ecology and Management, 25: 683-701. https://doi.org/10.1007/s11273-017-9544-0

[32] Austin, K.G. , Mosnierb, A., Pirkerb, J., McCallumb, I., Fritzb, S., Kasibhatlaa, P.S. (2017). Shifting patterns of oil palm driven deforestation in Indonesia and implications for zero-deforestation commitments. Land Use Policy, 69: 41-48. https://doi.org/10.1016/j.landusepol.2017.08.036

[33] Muhjad, M.H. (2016). The control of oil palm plantations in wetlands through spatial planning in South Kalimantan, Indonesia in the Context of Climate Change. Law Journal, 1(1): 1-16. http://dx.doi.org/10.32801/damai.v1i1.245

[34] Fujita, M.S., Samejima, H., Haryadi, D.S., Muhammad, A., Irham, M., Shiodera, S. (2016). Low conservation value of converted habitat for avifauna in tropical peatland on Sumatra, Indonesia. Ecological Research, 31(2): 275-285. https://doi.org/10.1007/s11284-016-1334-2

[35] Dommain, R., Couwenberg, J., Glaser, P.H., Joosten, H., Suryadiputra, I.N.N. (2014). Carbon storage and release in Indonesia since the last deglaciation. Quaternary Science Reviews, 971: 1-32. https://doi.org/10.1016/j.quascirev.2014.05.002