The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10853224

ECONOMIC VALUE OF AGROFORESTRY SCENARIO PALUDICULTURAL MODEL IN THE PEATLANDS OF SOUTH SUMATRA INDONESIA

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Abstract

This research examines the economic values of the agroforestry paludiculture scenario model as restoration of degraded peatlands in OKI Regency, South Sumatra, Indonesia. The increasingly chronic problem has forced the government, academics and society to work together to resolve conflicts on peatlands. The application of the paludiculture model, which is an easy-to-implement method, preserves the peat ecosystem by planting in flooded land conditions and peatland adaptive plants. The research method uses a qualitative and quantitative approach through questionnaires and interviews with farmers who own and try to farm on peatlands and use peatlands as a place to earn a living. The findings show that the economic value of the agroforestry scenario of a paludiculture with a combination of nyamplung-paddy-duck has a positive NPV value of Rp. 343,013,632 Rp/year. The results show that the business conditions are profitable and feasible to run. The sensitive rate value is sensitive where price changes will result in changes in the NPV value received by farmers. To overcome production factor constraints, it is necessary to find a solution by expanding the market so that farmers are not limited to local markets only and cause production costs to not return on investment when prices increase. It was found that there were 13 marketing channels that farmers could choose to market their products to consumers. Markets need to be prepared for farmers, considering that agricultural products are classified as perishable commodities. Therefore, the parties involved in the current collaboration influence the success of the paludiculture model implemented by farmers on peatlands.

Keywords: Paludiculture, Agroforestry, Economy, Nyamplung, NPV

INTRODUCTION

The vast peatlands owned by Indonesia have been looked at to change the function of sustainable natural ecosystems into economic functions (Barbier & Burgess, 2024; Budiman, Bastoni, et al., 2020; Evers et al., 2017; Nightingale et al., 2018). The interaction of ecology and economy will have a symbiotic relationship (Page & Baird, 2016). It was hoped that this interaction could support the progress of the ecosystem and economy of communities in peat areas (Gunawan, 2018a). Interactions have been going on for a long time, but people only continue to take existing resources without being able and willing to manage these resources into a sustainable source of livelihood (K. et al., 2018; Widiyanto et al., 2023). The impact of incorrect peatland management has caused widespread fires, as has occurred repeatedly, especially in Sumatra and Kalimantan (Dohong, 2016; Sarmiasih & Pratama, 2019).

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The physical characteristics of peat land are marginal land, lacking nutrients, acidic and flammable (Wasis et al., 2019). Comprehensive management is needed to overcome the consequences of peatland processing for the community (Andersen et al., 2017; K. et al., 2018; Syahza et al., 2020). Peatlands must be continuously flooded to prevent fires, so a combination of technology is needed to cultivate on peatlands (Chimner et al., 2017). The government's peatland restoration agency offers the 3R concept (Rewetting, Revegetation and Revitalization) (Jessup et al., 2020; R.K. & D., 2021; Terzano et al., 2022).

Peatlands are managed by applying the 3R principles, efforts to reduce fires by clearing, reforesting peatlands and creating livelihood opportunities for peat area communities (Miller, 2022; Mishra et al., 2021). Paludiculture technology is an alternative that can be applied to support the 3R principles (FAO, 2012). Paludiculture is cultivation in wetlands that are always flooded with water where the process is complex, easy to implement (Ziegler et al., 2021)(Giesen, 2015). The paludiculture model is an alternative solution offered for processing peatlands in an integrated manner. Apart from that, the function of peatlands cannot be ignored because it is the area that absorbs the most carbon. For this reason, its sustainability must be maintained and managed well. There has been a lot of research carried out on peatland restoration such as (Tan et al., 2021) analyzing the sustainable use of tropical peatlands using the paludiculture model. This study explains the function of paludiculture as a balancer for the ecosystem in absorbing carbon and becoming a sustainable agriculture. The findings are that paludiculture has benefits for ecosystem services, hydrological conditions and selection of cultivated vegetation.

The results of these findings are an evaluation and progress in expanding development with the paludiculture concept. Furthermore (Budiman, Bastoni, et al., 2020) reviewing the effectiveness and progress of paludiculture projects (agrisilviculture and agrosilvofishery) with commodities (jelutung-ramin-sulfur) and using rewetting, revegetation and livelihood revitalization approaches on peatlands. The findings from this study are that there are limitations to the use of paludiculture principles in the two project models which have different contributions to peatland restoration. (Ziegler, 2020) studying the sustainability of peatland agriculture by relying on the innovative mission of the paludiculture model. The findings from the research show that the path of palmiculture cultivation is intensive land use, shows strategies for farmers in institutional conversion that are more productive and there are 3 schemes, namely innovation, mission and ways to create the sustainability of paludiculture.

However, unfortunately there is still a lack of research on the economics of alternative commodity combinations in implementing the paludiculture model in South Sumatra, Indonesia. From the various phenomena that have been raised in the background, the aim of the research is to show a combination of the paludiculture model with the nyamplung-paddy-duck commodity agroforestry scenario. This research will review in detail the economics of the agroforestry scenario's paludiculture model as well as the feasibility of a business that can be accepted by farmers as an alternative for sustainable cultivation on peatlands. This research uses a qualitative and quantitative approach using questionnaires to collect interview data from farmers in OKI Regency, South Sumatra who have peatlands. It is hoped that this research can

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ISSN 1533-9211
DOI: 10.5281/zenodo.10853224

be a reference for farmers in selecting combinations of cultivation commodities on peatlands using the paludiculture model. It is hoped that the findings of this research will provide consideration and intervention for the government in sustainable peatland management for farmers, so that ongoing problems resulting from peatland fires can be overcome, create livelihoods, improve the welfare of farmers, and create a balance in an integrated natural ecosystem.

METHOD

This research was conducted in OKI Regency, South Sumatra, Indonesia. This research was raised because of the many problems related to peatlands which caused communities around peat areas to lose their livelihoods due to fires in peatlands. Often advances in technological science continue to be explored. Efforts to restore peatlands have led researchers to study the economics of the agroforestry scenario of a paludiculture model in the peatlands of South Sumatra, Indonesia. The research was conducted from September 2023 to January 2024. The research method used qualitative and quantitative approaches to identify problems and cultivate agroforestry using a combination of nyamplung-rice-ducks in OKI Regency, South Sumatra, Indonesia. Qualitative approach to look at the characteristics of farming communities, farming experience, community views about farming on peatlands. A quantitative approach to see and identify the application of the agroforestry scenario of the paludiculture model, from investment costs, operations, production to income. This research also uses a literature review as a reference to complement and confirm that many agroforestry models have been implemented but the right and efficient combination of commodities will be suitable for farmers' lives on peatlands.

Problem analysis uses direct benefit cost analysis and indirect benefit analysis by analyzing the overall economic value. Profitability analysis is broadly divided into 2 parts, namely financial analysis using NPV, BCR, IRR, PP indicators and sensitivity analysis to see the results of financial feasibility analysis based on various possibilities that occur. In fact, the use of data analysis using cost-benefit research has been carried out in many previous studies (Adriani et al., 2023; Budiman, Bastoni, et al., 2020; de Jong et al., 2021; Glenk & Martin-Ortega, 2018; Gunawan, 2018b; Ulya et al., 2021) However, assumptions and scenarios will differentiate the results of this research. Meanwhile, to assess the benefits of a paludiculture scenario on degraded peatlands from restoration efforts, an Extended Cost Benefit Analysis approach will be used (Growth et al., 2014). Multiplying the production quantity with the determined selling price is the total revenue. In general, the mathematics is formulated:

$$TR = Y \,.\, Py$$

Information:

TR = Revenue (Rp)

Y = Production obtained from a farming business (Kg)

Py = Production price (Rp)

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The reduction between total revenue and total production costs is net income or profit. The mathematics is formulated as follows:

$$\pi = TR - TC$$

$$\pi = Y\,.Py - \{(\Sigma Xi\,.Pxi) - BTT\}$$

Information:

π	= Income (Rp)	TR	= Overall income (Rp)
C	= Overall cost (Rp)	Y	= Production amount (kg)
Py	= Production price (Rp/unit)	Xi	= Production factor
Pxi	= Price of production factors (Rp)	TBT	= Total fixed costs (Rp)

NPV (Net Present Value)

NPV is the net present value. This variable is based on the concept of discounting all cash flows to their present value to obtain a net value. If the NPV value is > 0 then it is called a viable business, if the NPV < 0 then it is called an unviable business. The formula is:

$$\text{NPV} = \sum_t^n = \frac{(C)^t}{(1+i)^t} - \sum_t^n = 0\ \frac{(Co)^t}{(1+i)^t}$$

Where:

i = Interest per period

N = Period (year, month)

- C = Capital (capital)

C = Net results (proceeds)

BCR (Benefit Cost Ratio)

BCR is the division between the discounted value of benefits and costs. If the value is > 1 then it is called a viable business, if the value is < 1 then it is called an unfeasible business. The BCR formula is as follows:

$$\text{BCR} = \frac{Benefit}{cost}$$

IRR (Internal Rate of Return)

IRR is the acceptable level of efficiency of an investment. The amount of IRR cannot be determined directly, with a simulated value of NPV=0 as a prerequisite. The IRR formula is:

$$\sum_t^n = 0\frac{(C)^t}{(1+i)^t} - \sum_t^n = 0\ \frac{(Co)^t}{(1+i)^t}$$

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PP (Payback Period)

The length of time required for investment funds to be returned. There are 2 PPs, namely Simple Payback Period (does not take interest rates into account) and Discounted Payback Period (takes interest rates into account). The PP formula is as follows:

$$k_{(PBP)} = \sum_{t}^{k} = 0\ CF_t\ (FBP)_t$$

RESULTS AND DISCUSSION

South Sumatra has the second largest peatland area after Riau province (Noordwijk et al., 2011; Thorburn et al., 2013). Degradation due to human activities that are not compatible with the ecosystem, currently peatlands are still in the recovery stage (Mishra et al., 2021). Various efforts have been made to overcome the reduction of water during the dry season, the construction of canal blockades, the existence of economic activities that change peatlands into agricultural land by slashing, burning and drying which is not in accordance with the concept of life on peatlands (Syahza et al., 2020; Wildayana, 2017). As a result, many animals in peatlands become extinct.

Sumber: Source: JJ/Antara/Manggalaagni/Foc/OKI Sumsel/WRI

Figure 1. Problems faced in peatlands one way to restore the condition of peatlands is by restoring the function of wetlands. Conditions where the land is always watery, whether flooded or wet. Because the government has established a Peatland Restoration Agency in 2016, efforts are made to restore the land with a strategy of rewetting the peatland, so that it does not burn easily, as well as reforesting peat forest revegetation plants with native peatland commodities,

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and efforts to improve the standard of living of the people around the land. Peat innovates peat forest products without having to damage the ecological function of peat. According to research results (Budiman, et al., 2020) that alternative community livelihood efforts have not supported the restoration of peatlands. Such as dragon fruit, coffee and pineapple farming which has been carried out in Kalimantan and also Jambi, because this farming requires draining the land. (Budiman, et al., 2020) stated that in order to restore peatlands and alternative community livelihoods in a sustainable manner and protect the environment, economy and society, it is necessary to implement a paludiculture model with an integrated economic zone in the concept of an economic zone pilot area (SPEZ).

Various Alternative Livelihoods that Exist in OKI Regency, South Sumatra

Alternative livelihood efforts for local communities in peat areas continue to be studied and updated in line with the problems and concepts of peat forest sustainability. Alternative livelihoods on peatlands are in line with restoration efforts because land degradation causes people to lose places to earn a living and reduced income. Various studies have attempted to examine alternatives to increase income, but have not provided significant changes (Azni et al., 2023; Pusvita et al, 2023; Wildayana, 2017; Winarno et al., 2020, 2022). According (Adriani et al., 2023) The most important thing that must be known is what livelihoods have been carried out by local peatland communities, then form a scenario to create alternative livelihoods to increase income by managing peatlands according to the peat ecosystem and helping the restoration of degraded peat. An example of existing livelihoods is purun which is typical of peat plants. Purun has become a lot of innovative derivative products such as bags, sandals, mats, baskets, key chains. Apart from that, people's livelihoods are on peatlands, raising swamp cattle, processing smoked fish, planting sonor rice and cultivating vegetables for daily life.

This research also produces alternative livelihoods by applying the paludiculture model on peatlands with a combination agroforestry scenario of nyamplung-rice-ducks.

Table 1: Commodities, Benefits and Distribution of Growing Commodities on Peatlands

No	Commodity	Benefits	Grow in the Region
1	Nyamplung *(Calophyllum inophyllum*)	Optimizing land and vegetable energy sources. It has a lot of fruit as an oil potential of around 30-74%, and the waste can also be recycled.	Sumatera, Jawa, Bali / Nusa Tenggara, Kalimantan, Sulawesi, Maluku, Irian Jaya Barat, Papua
2	Rice (*Oryza sativa)*	Rice is a food crop which is the staple food of Indonesian people. The rice varieties that excel on peatlands are: Inpari 4, 10, 11, 13, Mekongga, Ciherang.	Kalimantan, Sumatera dan Irian Jaya
3	Duck (*Anatidae)*	Ducks are one of the livestock that can be raised on peatlands, according to their living conditions, ducks like places that are flooded with water, and eat earthworms in addition to their animal feed. Duck farming is a symbiotic mutualism for the environment and farmers.	Sumatera, Kalimantan

Source: literature study

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ISSN 1533-9211
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(Table 1) Utilization of forest commodities, food, fruit and livestock can be an alternative choice for a combination of efforts to improve community welfare. Recovery efforts are also being carried out, which aim to protect peat forests from fires, carbon evaporation and land use by diversifying farming (Maftu'ah et al., 2021; Osaki & Tsuji, 2015).

Agroforestry

Agroforestry is land use by combining woody plants with agricultural crops and livestock (Sitepu et al., 2017; VERMA et al., 2016; Wilson & Lovell, 2016). The combination of the woody tree environment used by livestock and other animals such as fish and honey bees is an agroforestry system. In principle, the implementation of agroforestry applies a holistic and systemic concept to achieve comprehensive and sustainable food security for the community and the existing ecosystem. Agroforestry uses planning with an appropriate technology system. Ecological interactions provide mutualistic benefits economically and environmentally.

Figure 2. Example of implementing an agroforestry model on a demonstration plot

The concept of biodiversity in the agroforestry pattern improves the degradation of the natural peat environment, restores the ecosystem's function according to its function, and provides benefits to the surrounding community as an effort to earn a sustainable living (Afentina et al., 2021; Lestari & Mukhlis, 2021). It's not like before just taking existing biological benefits, and not trying to preserve them again. Like the agroforestry scenario applied on peatlands with a combination of Nyamplung-rice-duck plants. This biodiversity, with a sustainable concept, will provide long-term added value.

Cost Benefits Direct and indirect

Costs and benefits will often be in line, the business or funds spent will gain benefits or profits from the business process. In principle, every business will have direct and indirect costs and benefits. Costs are funds spent on all farming activities (Asenso-Okyere et al., 2011; Christie et al., 2018; Simtion, 2021). Costs are divided into direct and indirect costs. Direct costs are costs that are directly incurred in the production process, for example operational costs. Meanwhile, indirect costs are costs incurred by production planning, or consequences arising from the production itself, for example investment costs, unforeseen costs (Table 2).

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Description of costs in each scenario of the paludiculture model, namely agroforestry, is categorized into investment costs, depreciation, contingencies and operational costs.

Table 2: Description of Agroforestry Model Costs

Uraian	Agroforestry
Investment (Rp/Project)	Rp. 91.660.000
Depreciation (Rp	Rp. 4.940.000
Contingency 10%	Rp. 9.166.000
Operational Costs (average/year)	Rp. 41.018.857

Using shared costs in each scenario will save and streamline funds and time during the planting season on the same land using an intercropping pattern. These shared costs will maximize production profits (Uda et al., 2020; Van Der Meer et al., 2021). Cost advantages of Joint intercropping patterns, 1). Having various harvest periods, 2) waiting for annual crop harvests, with an intercoppring pattern you can harvest seasonal crops first. 3). Has short, medium and long term income.

Table 3: Description of Benefits and BEP of Agroforestry Model

Commodity	Production	Revenue (Rp)	BEP (Rp)	Selling price	BEP Unit
Agroforestry					
Nyamplung fruit	43618 fruit	87.235.714	49.754.153 /period	2.500	19.902 kg/35 year
Paddy	3200 kg	32.000.000	18.250.930 /period	12.000	1.521 kg/year
Abandoned ducks	210 tail	7.350.000	4.192.010 /period	35.000	120 kg/year
Duck Eggs	13.650 kg	34.125.000	19.462.906 /period	2.500	7.785 kg/year

(Table 3) Shows the benefits of the agroforestry scenario model for each intercropping plant. This selection is made according to the derivative benefit scenario (Roziaty, 2023). This scenario provides an overview and benefits for farmers, to adopt the model. Providing multiple benefits, over a sustainable period of time farmers obtain seasonal, annual and decades-long benefits. For example, the nyamplung plant whose benefits will be felt for decades to produce wood. Meanwhile, nyamplung is a biofuel plant that at the age of 7-8 years will produce fruit which has many benefits as a biofuel producer. Meanwhile, the benefits of rice and duck eggs can be felt every 3-4 months. Then the annual commodity of rejected ducks is useful for at least 1 year, harvested and sold. Indirectly, farmers benefit from continuous profits, and on the other hand, the environment is protected.

Table 4: Financial Feasibility of Agroforestry Model Businesses

Uraian	Agroforestry
Net present value (NPV)	Rp. 343.013.632 year
IRR	26 %
Net B/C	6,01 year
Gross B/C	3,63 year
Payback Periode (PP/year)	0,32 year

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ISSN 1533-9211
DOI: 10.5281/zenodo.10853224

(Table 4) shows the results of the agroforestry scenario with NPV and IRR values which are quite feasible and profitable for farmers to carry out and apply on peatlands. The interest rate (IRR) is above 7% of the interest rate used, this means that the intercropping business is quite profitable for farmers. The type of plant chosen is very important to support people's income. Likewise, research results (Jahan et al., 2022) use the concept of an agroforestry scenario, where the scenario uses 5 types of tree plants combined with 3 types of vegetable plants. Vegetable crops are seasonal crops where the harvest time is quicker, becoming an alternative for short-term livelihood sustainability of the community and also the use of annual crops to cope with long-term livelihoods. (Afentina et al., 2021)(Asmaliyah et al., 2020)(Ekawati et al., 2021)(Yuwati et al., 2021) formulating policies, one of the strategies, is exploring the development of participation in the implementation of agroforestry peatland demonstration plots, alternative livelihood efforts and efforts to overcome degradation. Peatlands.

Analysis of the Sensitivity Rate of the Paludiculture Model

The sensitivity rate aims to see changes caused by an increase in production costs at a certain percentage. In this research, it is assumed that seeds and feed have increased by 5%. (Table 5) sensitivity rate conditions in the paludiculture model scenario.

Table 5: Agroforestry Scenario Sensitivity Rate

Criteria	Sensitivity Rate	Information
	Agroforestry	
NPV	17,84	Sensitive
IRR	22,61	Sensitive
Net B/C	15,35	Sensitive
Gross B/C	9,81	Sensitive
PP	10,25	Sensitive

(Table 5) shows the sensitivity of the paludiculture model scenario. The theoretical concept is that if there is an increase in the price of production costs, it will affect the farming process. It can be seen that NPV, IRR, Net B/C, Gross B/C and PP have experienced a shift, where this change from before the increase will shift to a value called sensitivity rate or sensitivity.

Alternative Marketing for Paludiculture Model Products

Marketing is an entity that must exist when the product is created. There are many and long channels in marketing to reach consumers. Marketing channels are chains or paths through which products are distributed from producers, intermediaries to final consumers(Watson et al., 2015). The choice of the length of the marketing channel is related to whether or not the farmers have information to distribute or sell directly to consumers. Often, farmers are only producers and some farmers are bound by agreements with middlemen. The impact is that farmers cannot determine the price of their own products. But as long as the business is successful, it is possible that there will be a market. Production from peat soil is increasing and continues to be explored. So that the livelihood of farmers is not only for cultivators, but farmers also have the opportunity to become market agents. Seen in the schematic (figure 3).

ISSN 1533-9211

DOI: 10.5281/zenodo.10853224

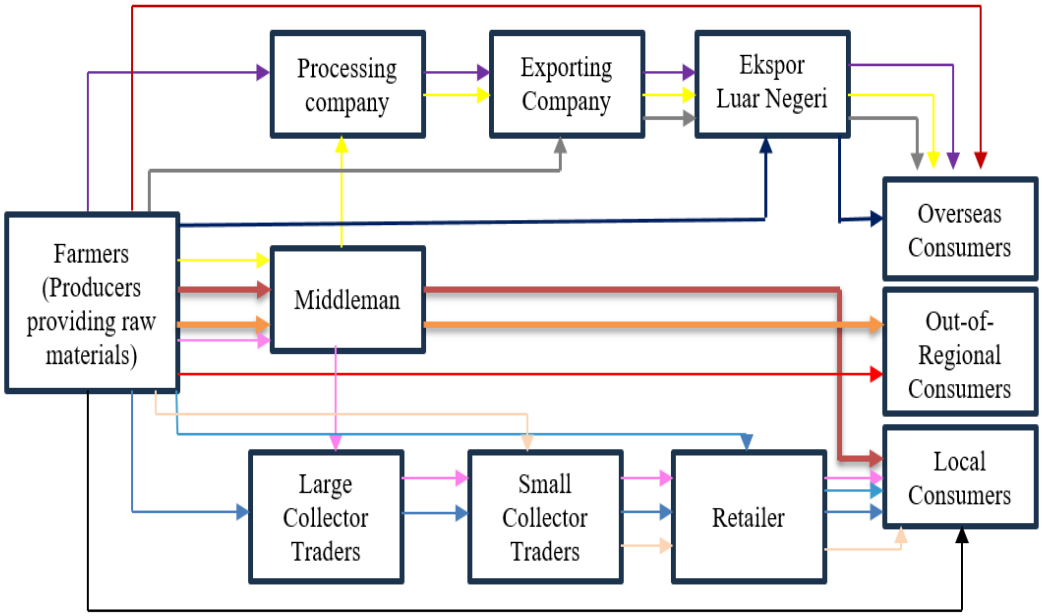

Figure 3: Alternative Scheme for Marketing Channels for Paludiculture Model Products from Farmers to Consumers

Alternative marketing channels focused on farmers include 13 channels that farmers can use to get to the market or directly to consumers. The commodities offered as a result of this research are varied, and can be used as local, foreign or foreign commodities. For example, the jelutung plant, apart from wood, produces sap. In several studies in Kalimantan, there are many companies that export and sell raw material products to Singapore and Japan (Asian & Bank, 1972; Lindblad, 1985). As well as other commodities, it is an opportunity for farmers to sell to local, national or international markets (Ferris et al., 2014).

CONCLUSION

Restoration efforts and community livelihoods on peatlands are expected to go hand in hand and mutually benefit both. Processing has been carried out frequently and extensively on peatlands, but has not produced a significant impact. The condition of peatlands that are flammable has forced the government and policy makers to place restrictions on peatland processing. Peatland exploration that does not prioritize ecological and economic interactions can invite mistakes that are fatal to the condition of the peat ecosystem. So, through the peatland restoration agency, the government is implementing the 3R strategy. If people want to cultivate peat land, they must prioritize the principles of land wetting, revegetation of peat plant types and sustainable efforts to revitalize peat products. The strategy can be implemented using the agroforestry scenario Hammerdikutur model. The NPV value is positive and profitable enough to be applied to farmers on peatlands. Choosing a combination of commodities is a priority that must be considered. When production costs experience an increase in price, it will have an impact on the NPV value obtained, the results of which are sensitive, namely experiencing

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ISSN 1533-9211
DOI: 10.5281/zenodo.10853224

changes when prices increase. Apart from that, there are 13 marketing channels that farmers can choose to market their products to consumers. Markets need to be prepared for farmers, considering that agricultural products are considered perishable commodities.

References

1) Adriani, D., Yazid, M., Damayanthy, D., Choi, E., & Yang, H. (2023). *Analysis of Livelihood Alternatives in Restored Peatlands Areas in South Sumatra Province , Indonesia*.

2) Afentina, Yanarita, Indrayanti, L., Rotinsulu, J. A., Hidayat, N., & Sianipar, J. (2021). The Potential of Agroforestry in Supporting Food Security for Peatland Community – A Case Study in the Kalampangan Village, Central Kalimantan. *Journal of Ecological Engineering*, *22*(8), 123–130. https://doi.org/10.12911/22998993/140260

3) Andersen, R., Farrell, C., Graf, M., Muller, F., Calvar, E., Frankard, P., Caporn, S., & Anderson, P. (2017). An overview of the progress and challenges of peatland restoration in Western Europe. *Restoration Ecology*, *25*(2), 271–282. https://doi.org/10.1111/rec.12415

4) Asenso-Okyere, K., Asante, F. A., Tarekegn, J., & Andam, K. S. (2011). A review of the economic impact of malaria in agricultural development. *Agricultural Economics*, *42*(3), 293–304. https://doi.org/10.1111/j.1574-0862.2010.00515.x

5) Asian, T., & Bank, D. (1972). *A Case Study of Industrialisation and Foreign*. *8*(June).

6) Asmaliyah, Hadi, E. E. W., Irianto, R. S. B., Imanullah, A., Bastoni, Siahaan, H., & Purwanto. (2020). Bagworm infestation on Shorea balangeran in the degraded peatland restoration plot. *IOP Conference Series: Earth and Environmental Science*, *533*(1). https://doi.org/10.1088/1755-1315/533/1/012041

7) Azni, U. S., Alfitri, Yunindyawati, Riswani, & Pellizzoni, L. (2023). Adaptive Capacity of Indonesian Peatland Communities Facing Resource Loss and Fires Threats: Studies on Purun (Eleocharis dulcis) Craftsmen. *International Journal of Design and Nature and Ecodynamics*, *18*(5), 1223–1228. https://doi.org/10.18280/IJDNE.180524

8) Barbier, E. B., & Burgess, J. C. (2024). Economics of Peatlands Conservation, Restoration and Sustainable Management. In *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.4695533

9) Budiman, I., Bastoni, Sari, E. N., Hadi, E. E., Asmaliyah, Siahaan, H., Januar, R., & Hapsari, R. D. (2020). Progress of paludiculture projects in supporting peatland ecosystem restoration in Indonesia. *Global Ecology and Conservation*, *23*, e01084. https://doi.org/10.1016/j.gecco.2020.e01084

10) Budiman, I., Januar, R., Daeli, W., Hapsari, R. D., & Sari, E. N. (2020). Designing the special pilot economic zone on peatlands. *Jurnal Geografi Lingkungan Tropik*, *4*(1). https://doi.org/10.7454/jglitrop.v4i1.73

11) Chimner, R. A., Cooper, D. J., Wurster, F. C., & Rochefort, L. (2017). An overview of peatland restoration in North America: where are we after 25 years? *Restoration Ecology*, *25*(2), 283–292. https://doi.org/10.1111/rec.12434

12) Christie, R., Tidey, C., & Mccarthy, I. (2018). *The Direct And Indirect Costs Of Consenting Dairy Farms Under Horizons One Plan (Prior To March 2017 Environment Court Declaration)*. *31*, 1–10.

13) de Jong, M., van Hal, O., Pijlman, J., van Eekeren, N., & Junginger, M. (2021). Paludiculture as paludifuture on Dutch peatlands: An environmental and economic analysis of Typha cultivation and insulation production. *Science of the Total Environment*, *792*, 148161. https://doi.org/10.1016/j.scitotenv.2021.148161

14) Dohong, A. (2016). *an Assessment of the Restoration Efforts of Degraded Peatland*.

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10853224

15) Ekawati, S., Sylviani, Surati, Ramawati, Handoyo, Prasetyo, B. D., Lugina, M., Hidayat, D. C., Sumirat, B. K., Hardiansyah, G., Mariani, Y., Yusro, F., Oktoria, S., Kusrini, N., Pranoto, D. Y., & Roslinda, E. (2021). Factors affecting communities in adopting sustainable peat cultivation techniques and strategies for implementation (a case study in Pulang Pisau, Central Kalimantan). *IOP Conference Series: Earth and Environmental Science*, *917*(1). https://doi.org/10.1088/1755-1315/917/1/012022

16) Evers, S., Yule, C. M., Padfield, R., O'Reilly, P., & Varkkey, H. (2017). Keep wetlands wet: the myth of sustainable development of tropical peatlands – implications for policies and management. *Global Change Biology*, *23*(2), 534–549. https://doi.org/10.1111/gcb.13422

17) FAO. (2012). Peatlands – guidance for climate change mitigation by conservation , rehabilitation and sustainable use Peatlands - guidance for climate c Ś ange mi Θ ga Θ on d'LJ conser l a Θ on ¸re Ś a d' ilita Θ on and sustaina d' le use. *Mitigation Of Climate Change In Agriculture Series 5*.

18) Ferris, S., Robbins, P., Best, R., Seville, D., Buxton, A., Shriver, J., & Wei, E. (2014). Linking Smallholder Farmers to Markets and the Implications for Extension and Advisory Services - MEAS Discussion Paper Series on Good Practices and Best Fit Approaches in Extension and Advisory Service Provision. *MEAS Brief*, *4*(10), 1–46. www.meas-extension.org

19) Giesen, W. (2015). Utilising non-timber forest products to conserve Indonesia ' s peat swamp forests and reduce carbon emissions. *Journal of Indonesian Natural History*, *3*(2), 69–72.

20) Glenk, K., & Martin-Ortega, J. (2018). The economics of peatland restoration. *Journal of Environmental Economics and Policy*, *7*(4), 345–362. https://doi.org/10.1080/21606544.2018.1434562

21) Growth, G., Government, T., Green, G., & Program, G. (2014). *Extended Cost Benefit Analysis Scoping Paper October 2014*. *October*, 1–17.

22) Gunawan, H. (2018a). Indonesian peatland functions: Initiated peatland restoration and responsible management of peatland for the benefit of local community, case study in riau and west kalimantan provinces. In *Asia in Transition* (Vol. 7). Springer Singapore. https://doi.org/10.1007/978-981-10-8881-0_6

23) Gunawan, H. (2018b). Indonesian peatland functions: Initiated peatland restoration and responsible management of peatland for the benefit of local community, case study in riau and west kalimantan provinces. *Asia in Transition*, *7*, 117–138. https://doi.org/10.1007/978-981-10-8881-0_6

24) Jahan, H., Rahman, M. W., Islam, M. S., Rezwan-Al-Ramim, A., Tuhin, M. M. U. J., & Hossain, M. E. (2022). Adoption of agroforestry practices in Bangladesh as a climate change mitigation option: Investment, drivers, and SWOT analysis perspectives. *Environmental Challenges*, *7*(March), 100509. https://doi.org/10.1016/j.envc.2022.100509

25) Jessup, T., Segah, H., Silvius, M., Applegate, G., & Jagau, Y. (2020). An Integrated Landscape Approach for Socially Inclusive Peatland Restoration. *Journal of Wetlands Environmental Management*, *8*(1), 77. https://doi.org/10.20527/jwem.v8i1.229

26) K., H., R., C., S., A., C., M., D., M., & H., P. (2018). Managing peatlands in Indonesia: Challenges and opportunities for local and global communities. *Managing Peatlands in Indonesia: Challenges and Opportunities for Local and Global Communities*, *205*. https://doi.org/10.17528/cifor/006449

27) Lestari, Y., & Mukhlis. (2021). Peatland water conservation by agroforestry system. *E3S Web of Conferences*, *305*. https://doi.org/10.1051/e3sconf/202130503004

28) Lindblad, J. T. (1985). Economic change in southeast kalimantan 1880–1940. *Bulletin of Indonesian Economic Studies*, *21*(3), 69–103. https://doi.org/10.1080/00074918512331335083

29) Maftu'ah, E., Susilawati, A., & Sulaeman, Y. (2021). Agroforestry for restoration of degraded peatlands. *E3S Web of Conferences*, *305*, 1–8. https://doi.org/10.1051/e3sconf/202130503001

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10853224

30) Miller, M. A. (2022). Market-based commons: Social agroforestry, fire mitigation strategies, and green supply chains in Indonesia's peatlands. *Transactions of the Institute of British Geographers*, *47*(1), 77–91. https://doi.org/10.1111/tran.12472

31) Mirza;, P. E. M. A. A. D. (2023). *Farmers ' Interest and Economics Model of Agrosilvofishery Restoration on Degraded Peatland in*. *1*(3), 99–111.

32) Mishra, S., Page, S. E., Cobb, A. R., Lee, J. S. H., Jovani-Sancho, A. J., Sjögersten, S., Jaya, A., Aswandi, & Wardle, D. A. (2021). Degradation of Southeast Asian tropical peatlands and integrated strategies for their better management and restoration. *Journal of Applied Ecology*, *58*(7), 1370–1387. https://doi.org/10.1111/1365-2664.13905

33) Nightingale, S., Spiby, H., Sheen, K., & Slade, P. (2018). Tropical forest and peatland conservation in Indonesia: Challenges and directions. *Tourism Recreation Research*, 19. http://researchonline.ljmu.ac.uk/id/eprint/8705/

34) Noordwijk, M. Van, Dewi, S., Agus, F., Ekadinata, A., Suyanto, Tata, H. L., Galudra, G., & Pradhan, U. P. (2011). Opportunities for Reducing Emissions From all Land Uses in Indonesia. Policy Analysis and Case Studies. *ASB Partnership for the Tropical Forest Margins*, 1–93.

35) Osaki, M., & Tsuji, N. (2015). Tropical peatland ecosystems. *Tropical Peatland Ecosystems*, 1–651. https://doi.org/10.1007/978-4-431-55681-7

36) Page, S. E., & Baird, A. J. (2016). Peatlands and Global Change: Response and Resilience. *Annual Review of Environment and Resources*, *41*, 35–57. https://doi.org/10.1146/annurev-environ-110615-085520

37) R.K., B., & D., M. (2021). Effective monitoring and management of peatland restoration. *Effective Monitoring and Management of Peatland Restoration*. https://doi.org/10.17528/cifor/008142

38) Roziaty, E. (2023). Trade-off between carbon offset and economic benefit: Potential of cocoa-based agroforestry systems in the voluntary carbon market. *Journal of Agriculture and Rural Development in the Tropics and Subtropics*, *124*(2), 101–114.

39) Sarmiasih, M., & Pratama, P. Y. (2019). The Problematics Mitigation of Forest and Land Fire District Kerhutla) in Policy Perspective (A Case Study : Kalimantan and Sumatra in Period 2015-2019). *Journal of Governance and Public Policy*, *6*(3). https://doi.org/10.18196/jgpp.63113

40) Simtion, D. (2021). *Analysis of indirect expenses rates*. *21*(4), 523–526.

41) Sitepu, D. S. M., Tinhout, B., & van Amstel, A. (2017). *Agroforestry-based paludiculture compositions in Indonesian tropical peatlands*. *2025*.

42) Syahza, A., Suswondo, Bakce, D., Nasrul, B., Wawan, & Irianti, M. (2020). Peatland Policy and Management Strategy to Support Sustainable Development in Indonesia. *Journal of Physics: Conference Series*, *1655*(1). https://doi.org/10.1088/1742-6596/1655/1/012151

43) Tan, Z. D., Lupascu, M., & Wijedasa, L. S. (2021). Paludiculture as a sustainable land use alternative for tropical peatlands: A review. *Science of the Total Environment*, *753*, 142111. https://doi.org/10.1016/j.scitotenv.2020.142111

44) Terzano, D., Attorre, F., Parish, F., Moss, P., Bresciani, F., Cooke, R., & Dargusch, P. (2022). Restoration Ecology - 2022 - Terzano - Community-led peatland restoration in Southeast Asia 5Rs approach.pdf. In *Restoration Ecology*.

45) Thorburn, C., Simon, C., & Rowntree, J. (2013). *Managing peatlands in Indonesia: A case study of small islands in Riau Province, Sumatra*. *October*. www.monash.edu/research/sustainability-institute/

46) Uda, S. K., Schouten, G., & Hein, L. (2020). The institutional fit of peatland governance in Indonesia. *Land Use Policy*, *99*(March), 0–1. https://doi.org/10.1016/j.landusepol.2018.03.031

The Seybold Report
ISSN 1533-9211
DOI: 10.5281/zenodo.10853224

47) Ulya, N. A., Waluyo, E. A., Nurlia, A., Rahmat, M., & Martin, E. (2021). Alternative natural capital-based livelihoods in facing peatland degradation in Rengas Merah hamlet, Ogan Komering Ilir Regency, Indonesia: A financial analysis approach. *IOP Conference Series: Earth and Environmental Science*, *917*(1). https://doi.org/10.1088/1755-1315/917/1/012017

48) Van Der Meer, P. J., Tata, H., Rachmanadi, D., Arifin, Y. F., Suwarno, A., & Van Arensbergen, P. (2021). Developing sustainable and profitable solutions for peatland restoration. *IOP Conference Series: Earth and Environmental Science*, *914*(1). https://doi.org/10.1088/1755-1315/914/1/012032

49) VERMA, S., SINGH, V., VERMA, D. K., & GIRI, S. P. (2016). Agroforestry practices and concepts in sustainable land use systems in Nigeria. *International Journal of Forestry and Crop Improvement*, *7*(1), 126–131. https://doi.org/10.15740/has/ijfci/7.1/126-131

50) Wasis, B., Saharjo, B. H., & Putra, E. I. (2019). Impacts of peat fire on soil flora and fauna, soil properties and environmental damage in riau province, Indonesia. *Biodiversitas*, *20*(6), 1770–1775. https://doi.org/10.13057/biodiv/d200639

51) Watson, G. F., Worm, S., Palmatier, R. W., & Ganesan, S. (2015). The Evolution of Marketing Channels: Trends and Research Directions. *Journal of Retailing*, *91*(4), 546–568. https://doi.org/10.1016/j.jretai.2015.04.002

52) Widiyanto, A., Sanudin, S., & Hani, A. (2023). Agroforestry on peatland: Livelihood options for community resilience to climate change adaptation. *Sustainable Forestry*, *6*(1), 1–11. https://doi.org/10.24294/sf.v6i1.2714

53) Wildayana, E. (2017). Challenging constraints of livelihoods for farmers in the South Sumatra Peatlands, Indonesia. *Bulgarian Journal of Agricultural Science*, *23*(6), 894–905.

54) Wilson, M. H., & Lovell, S. T. (2016). Agroforestry-The next step in sustainable and resilient agriculture. *Sustainability (Switzerland)*, *8*(6), 1–15. https://doi.org/10.3390/su8060574

55) Winarno, B., Lestari, S., Ramawati, & Syabana, T. A. A. (2022). Food security prospects of rural community in the change and degraded peatland landscape of South Sumatra. *IOP Conference Series: Earth and Environmental Science*, *1107*(1). https://doi.org/10.1088/1755-1315/1107/1/012037

56) Winarno, B., Rohadi, D., Herawati, T., Rahmat, M., & Suwarno, E. (2020). Out of fire disaster: Dynamics of livelihood strategies of rural community on peatland use and management. *IOP Conference Series: Earth and Environmental Science*, *487*(1). https://doi.org/10.1088/1755-1315/487/1/012008

57) Yuwati, T. W., Rachmanadi, D., Pratiwi, Turjaman, M., Indrajaya, Y., Nugroho, H. Y. S. H., Qirom, M. A., Narendra, B. H., Winarno, B., Lestari, S., Santosa, P. B., Adi, R. N., Savitri, E., Putra, P. B., Wahyuningtyas, R. S., Prayudyaningsih, R., Halwany, W., Nasrul, B., Bastoni, & Mendham, D. (2021). Restoration of degraded tropical peatland in indonesia: A review. *Land*, *10*(11). https://doi.org/10.3390/land10111170

58) Ziegler, R. (2020). Paludiculture as a critical sustainability innovation mission. *Research Policy*, *49*(5), 103979. https://doi.org/10.1016/j.respol.2020.103979

59) Ziegler, R., Wichtmann, W., Abel, S., Kemp, R., Simard, M., & Joosten, H. (2021). Wet peatland utilisation for climate protection – An international survey of paludiculture innovation. *Cleaner Engineering and Technology*, *5*. https://doi.org/10.1016/j.clet.2021.100305