Traditional knowledge of land management in Maybrat District, West Papua Province, Indonesia: implication for agriculture development

MEKY SAGRIM♥

Faculty of Agriculture, Universitas Papua. Jl. Gunung Salju, Amban, Manokwari 98314, West Papua, Indonesia.
♥email: mekysagrim@gmail.com

Abstract. *Sagrim M. 2022. Traditional knowledge of land management in Maybrat District, West Papua Province, Indonesia: implication for agriculture development. Biodiversitas 23: 4145-4152.* Traditional concepts of land management have been part of the local people in Maybrat, West Papua, Indonesia for generations. On the other hand, the governments, either at central, provincial, or local levels, promote agricultural development to enhance the well-being of the community in Maybrat and Papua in general. Thus, it is interesting to look at whether traditional knowledge and practices of land management in Maybrat can be aligned with development policies enacted by the governments. This research aimed to investigate the traditional knowledge of land management in Maybrat District to support agricultural development using an application of the socio-cultural approach. A semi-structured interview was applied for data collection representing communities of 24 sub-districts in Maybrat District. In total, 200 informants were selected purposely to obtain perceptual knowledge of the land-use system. The results showed that the local people benefit from natural resources in terms of social prominence, ecological prominence, economic prominence, medicinal prominence, energy prominence, and construction prominence. Agriculture is the main land use in Maybrat where it supports the livelihood of local people, especially in terms of economic benefit. Furthermore, the local people in Maybrat have been conducting their local wisdom to preserve the natural resource by using the traditional concepts where the local people have realized the function of vegetated land. Hence, development programs in the agricultural sector promoted by the regional or national governments could accommodate the local knowledge in land management. Yet, assessing the biophysical factors is necessary to monitor the dynamic of land management to achieve sustainability in socio-cultural, economic, and ecological aspects.

Keywords: Customary right, local people, New Guinea, socio-culture, swidden agriculture

INTRODUCTION

Papua is recognized as the mega diversity region which has the richest floristic diversity in the world (Cámara-Leret et al. 2020; Murdjoko et al. 2020, 2021b). The high diversity of species, as well as ecosystems, have benefited local people for generations in which their livelihoods are highly dependent on these species and ecosystems (Ungirwalu et al. 2014, 2017, 2019; Manik et al. 2018). Because of the long interaction and high dependency on natural resources, the local communities in Papua have developed indigenous traditional knowledge as local wisdom which could be used for its conservation (Karous et al. 2021; Martins and Shackleton 2021).

In recent times, some local communities in Papua have immersed themselves in modernization, yet to some extent, they still hold the traditions in their daily life. They still conduct the traditional uses of natural resources particularly in terms of forest utilization despite development programs implemented by the government in most areas including in West Papua Province (Burivalova et al. 2018; Indrawan et al. 2019). For instance, the implementation of regional autonomy has driven the development of the agricultural sector which includes the sub-sectors of agriculture, plantations, livestock, and fisheries. The role of the agricultural sector as a powerhouse of the regional economy is still dominant

considering that most Indonesian people depend on the agricultural sector for their main livelihood. Thus, the success of regional development is determined, among others, by the agricultural sector, both on a small and large scale (Gaveau et al. 2021; Ungirwalu et al. 2018).

Maybrat District is one of the newly established districts in Indonesia as a result of the division in the West Papua Province, Indonesia. To accelerate the development in this district, development planning based on reliable data and information is a very important aspect of developing evidence-based policy. In the early stages, the development planning process may be based more on the aspirations of the community according to their needs and interests. Nonetheless, in the next stage, it is hoped that the development planning process will be based on good data dan information particularly to support agricultural development focusing on the sustainable management of natural resources (UU 13/2009).

Agricultural activities have been carried out by the local people in Maybrat for generations and have also been part of their socio-cultural dynamics. Therefore, the understanding of how local people do agricultural activities is necessary to be aligned with the development programs proposed by local and/or central governments. For instance, the development program in the agricultural sector needs to be supported by planning based on the quality of land and environmental resources, human

resources, and market orientation to increase the independence of farmers and the welfare of the nation. One strategy to accelerate the development of the agriculture sector is by determining the zoning of agricultural areas at a district/city or provincial level. When determining an area for superior agricultural commodities, planning must pay attention to several aspects, including land carrying capacity, agro-climate suitability, and social and cultural adaptability. Such aspects are important to achieve the effectiveness and efficiency of agricultural development towards increasing the quality and quantity of sustainable agricultural commodity production.

Physio graphically, agricultural development planning should be carried out with a good study to determine regional-based commodity development patterns. Hence, this research was intended to reveal the traditional concepts in natural resource management in Maybrat District to support agricultural development using an application of the socio-culture approach. We expect the results of this study can be used as baseline information when developing agricultural policies and programs in Maybrat District.

MATERIALS AND METHODS

Study area

This study was conducted in 24 sub-districts in the Maybrat District, West Papua Province, Indonesia (Figure 1). The research was focused on the main sub-districts which were the result of the division of South Sorong District, namely Ayamaru, North Ayamaru, Mare, Aitinyo, Aifat, and East Aifat Sub-districts. However, the research also covered the sub-districts of the parent sub-district concerned. For example, the baseline data for the Ayamaru

Sub-district includes the sub-districts resulting from the division of the Maybrat District, namely, Ayamaru, West Ayamaru, South Ayamaru, Central Ayamaru, East Ayamaru, South East Ayamaru, and South Jaya Ayamaru. The sub-districts studied in the Maybrat District were based on the currently existing agricultural development by the community (existing data) combined with the potential development based on the agro-ecosystem conditions of each sub-district which, of course, may involve more than one sub-district and/or even breaking a sub-district into more than one development zones. The data were obtained between July and September 2021 by observing in the field and taking the interview with local people. The minimum, mean and maximum temperatures are 22.2ºC, 26.4ºC, and 33.7ºC respectively, while the minimum, mean, and, maximum humidity are 56%, 57.2%, and 99.8%, correspondingly. The mean rainfall per month is 275.4 mm with 19 rainy days. The elevation ranges from about 250 m to 500 m a.s.l. (Selatan 2020).

Data collection

The research method used the combination of interviews and direct observation of the subjects and objects of research. Data was collected using the purposive sampling method using questionnaires distributed to a total of 200 informants representing the 24 sub-districts in Maybrat District. The local people engaged in the utilization of natural resources in Maybrat were selected as informants. The observation in the fields and the interview with leaders of villages along with traditional figures were carried out to set candidates for informants. Then semi-structured interviews were performed by asking the informants to gain socio-economic data on gender, education, occupation, and age.
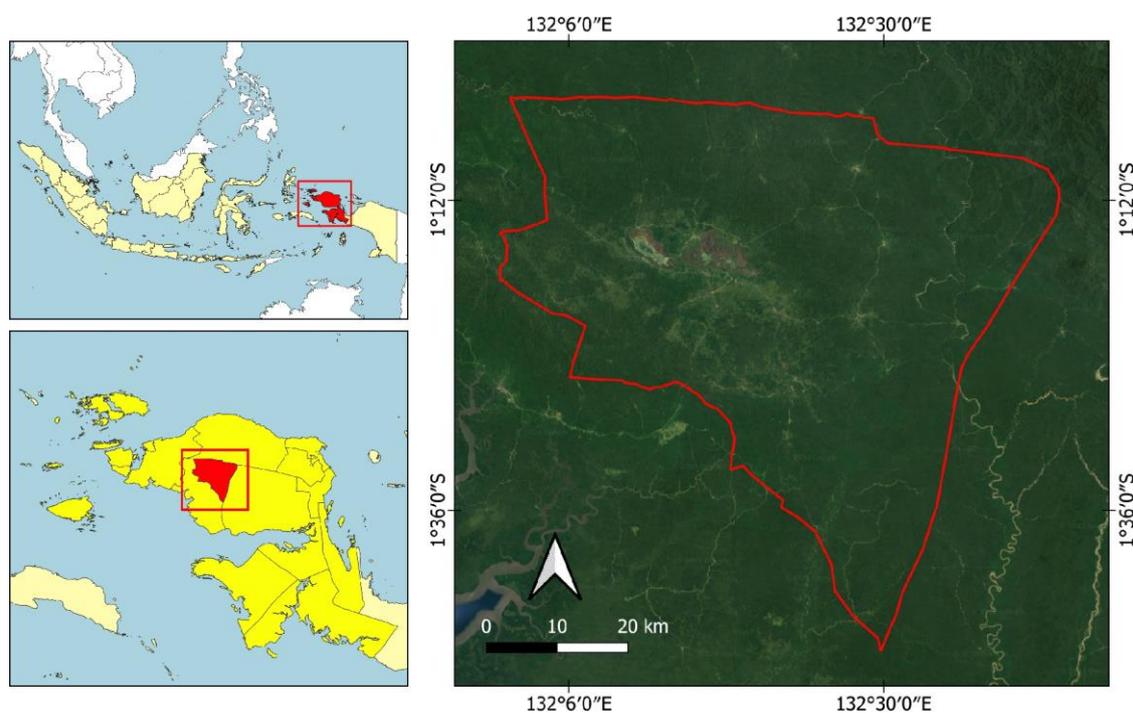

Figure 1. The study area of Maybrat District, West Papua Province, Indonesia (red-line)

Furthermore, the research also asked the perceptual knowledge to define the understanding of local people on how they obtain benefits from natural resources. The perceptual knowledge contained six categories, namely social prominence, ecological prominence, economic prominence, medicinal prominence, energy prominence, and construction prominence. The site visit was then performed according to information obtained from the informants, then pictures were taken in the fields.

Data analysis

Interviews were conducted by filling in data/information into a list of questions that had been prepared beforehand. Data were then analyzed using descriptive analysis by displaying the percentages (%) of socio-economic parameters where the number of the category was divided by the total of informants as follows:

$$P_i = \frac{n_i}{N} \times 100\ \%$$

Where: P_i is the proportion of socio-demographic characteristics (gender, education, occupation, and age group) in the percent (%), n_i is the number of socio-demographic characteristics (gender, education, occupation, and age group), and N is the total number of informants. Then, to analyze each perceptual knowledge (social prominence, ecological prominence, economic prominence, medicinal prominence, energy prominence, and construction prominence), the research also applied the percentage (%) by using the formula as follows:

$$PK_i = \frac{n_i}{N} \times 100\ \%$$

Where: PK_i is the proportion of perceptual knowledge in percent (%), n_i is the number of local people that answered "yes" to each category of perceptual knowledge, and N is the total number of informants. The percentage (%) of informants can be used to see the proportion of certain categories (Khan and Irshad 2022). The research also performed the photovoice analysis using picture capturing during activities of local people (Castleden et al. 2008). Afterward, the results of the analysis were depicted in Tables and Figures.

RESULTS AND DISCUSSION

Socio-demographic and perceptual knowledge

In this research, the interview was performed with 200 informants (Table 1) consisting of 106 men (53%) and 94 women (47%). Based on education level, the informants can be described as one informant who had no education (0.5%), two informants who took elementary school (1%), seven informants who studied in junior high school (3.5%), 116 informants who finished senior high school (58%), and 74 informants reached above high school (37%). Most of the informants (104 informants/ 52%) worked as farmers, 72 informants (36%) as government officials, 17 informants (8.5%) as fishermen, and 7 informants (3.5%) worked in the private sector. Based on age, the informants had age

above 60 years (9 informants, 4.5%), 51-60 year (29 informants, 14.5%), 41-50 years (46 informants, 23%), 31-40 years (47 informants, 23.5%), 21-30 years (43 informants, 21.5%), and below 20 years (26 informants, 13%).

The benefits from natural resources particularly in the form of vegetation were measured by asking the informants about their perceptual knowledge on this matter. Table 2 shows the percentage of informants for the six types of benefits viewed from particular prominence in which social prominence was perceived by 195 informants (97.5%), ecological prominence by 196 informants (98%), economic prominence by 200 informants (100%), medicinal prominence by 148 informants (74%), energy prominence by 200 informants (100%), and construction prominence by 200 informants (100%).

Socio-cultural features and patterns of leadership

Based on settlement area, the population of Maybrat District is divided into three regional zones, i.e. Ayamaru people who live in the north and south of Lake Ayamaru and share a border with Sorong District and Tambrauw District; The Aitinyo people who live in the south and inhabit the area along the Kais River bordering the Imekko tribe (Inanwatan, Metemani, Kais, and Kokoda), which borders the Fak-Fak District; Aifat people who live in the east and are located along the Kamundan River and directly adjacent to Teluk Bintuni District. The Maybrat tribe has one (single) language, namely the Maybrat language with 4 (four) dialects, of which 3 (three) dialects are quite widely used namely *Mai Awi* in the Ayamaru dialect; *Mai Tite* Aitinyo dialect; and *Mai Asmaun* in the Aifat dialect. The fourth dialect is the coastal dialect of the Kais River called *Mai Sefa Nagin*, but the users of this latter dialect are very limited.

Table 1. Socio-demographic characteristics of informants based on gender, education, occupation, and age group

Socio-demographic characteristics	Number of informants	Percentage (%)
Gender		
Female	94	47
Male	106	53
Education		
No Education	1	0.5
Elementary School	2	1
Junior High School	7	3.5
Senior High School	116	58
Above High School	74	37
Occupation		
Farmer	104	52
Official	72	36
Fisherman	17	8.5
Private	7	3.5
Age group (yr)		
Above 60	9	4.5
51-60	29	14.5
41-50	46	23
31-40	47	23.5
21-30	43	21.5
Below 20	26	13

Table 2. Perceptual knowledge of informants [in number (n) and percentage (%)] regarding the benefits of vegetation for their life

Perceptual knowledge	Informants (n)	Percentage (%)
Social prominence	195	97.5
Ecological prominence	196	98
Economic prominence	200	100
Medicinal prominence	148	74
Energy prominence	200	100
Construction prominence	200	100

The people in Maybrat, and the people of Papua generally, have a social structure that can be clearly distinguished according to indigenous peoples and migrant communities. These differences can be distinguished by clan, based on physical characteristics such as immigrants with straight hair and white skin, and also based on the language used. In the cultural concept, Papuans view indigenous peoples as people who for generations have inhabited certain places (villages) which are limited by certain natural objects such as rocks, trees, rivers, etc., and have customary rights to land for gardening, hunting, or searching. Livelihood and ownership are recognized by the community based on a knowledge system that has been passed down from generation to generation. The differences between indigenous communities and migrants in Papuan society, especially in Maybrat District, are usually distinguished by clan, but within a group of clans or clans in a certain area, there are also indigenous clans that hold customary rights and indigenous clans that are not the holders of customary rights. Indigenous clans who are not the holders of customary rights are generally recognized as native clans of certain regions, but according to knowledge, from generation to generation, they come from certain areas who moved due to marriage, war slaves, and others. They only have usufructuary rights over land, water, and forest resources, etc., but do not have the status of customary property rights, so those who decide to sell the resources are the indigenous clans who have customary rights.

The important value factors adopted by the Maybrat community are shown as means of paying dowry, traditional fines, and traditional parties so that they can determine the social status of a person or group of people, such as the upper class, middle class, and lower-class groups—which are referred to as *ra-bobot* (upper class), *ra-sai* (middle class), and *ra-kair/kinya*h (lower class)—use eastern fabrics/clothes. Based on the explanation above, it can be concluded that the people in this region have traditionally belonged to a class (elite) society. Advances in technology and modernization are now causing many people to be trapped in it, making people sometimes view modern instruments such as bureaucratic positions, education levels, and even money as a determining factor for people's social status to further sharpen social stratification into an elite society or class society. The kinship system with the pattern of inheritance of assets and the important value factors as described above is a patrilineal system. That is, when a newly married couple gets married and has children, their offspring will follow the father's family. Likewise, the inheritance of assets (important value) is passed down to the eldest son of the family. If there is more than one son, the distribution process is carried out by their parents as facilitators to determine the proportional distribution from the eldest to the youngest. However, if you do not have a son, it can be inherited by a son from one of the father's brothers. Likewise, if one does not have it, it can be returned as the communal property of the same basket from the original owner's carriage.

Permanent custom in Maybrat, as the Papuan people in general, is a virilocal custom, meaning that this custom requires newly married couples to live permanently at the center of their husband's relatives. However, there are outliers (approximately 5 per 1,000 people) who adhere to the uxorilocal custom, meaning that the wife who brings her husband to live permanently at the center of the wife's relatives. In cases where virilocal customs are adopted by a husband and wife, it is seen that this is a violation of ethics and customs, which are considered to reduce the dignity, worth, and dignity of the family. There are families, who because they do not accept the actions taken by their children who adhere to uxorilocal customs, then they deny it so that the child is asked to give the names of their children according to his wife's family.

The community in the Maybrat area adheres to an open social system (opened social stratification) which provides wide opportunities for anyone, including community groups of low status (not lower class) according to the customary structure of the Maybrat community to move from a lower status (lower class) to the middle class and/or lower class. The same thing can also be seen that outsiders who meet the requirements such as being able to read and write, good at diplomacy, good at hunting (leading war), must be from a native tribe, but if there is no one available, then it is permissible to come from another tribe to become a leader. The traditional leadership system adopted and developed by the people in this region is not very visible. Therefore, it is not possible to clearly describe the type of leadership that they adopted and developed. However, based on the results of interviews, it can be concluded that they adhere to the type of authoritative man in which the process of gaining power is due to struggle or effort (achievement). In addition to non-formal leadership, there are formal leaders, namely the village head, assisted by a deputy, a secretary, and several heads of affairs. When examined in terms of role models, the results of this study indicate that all matters are related to customs such as customary fines, settlement of young people's affairs, infidelity, etc. - in each village. On the other hand, affairs related to the formal government are mostly resolved by formal leaders such as village heads and all government officials. All government affairs and community development—both by formal government and customary government—are always carried out with the principle of mutual coordination. The pattern of decision-making is usually through a joint decision led by the village head. However, in determining the cost of land acquisition/customary rights, it is usually the community or clans that own customary rights to decide.

Natural resources and their benefits for local people in Maybrat

The people in Maybrat obtained various benefits from natural resources to be used in their socio-cultural activities such as weddings and other traditional ceremonies. They use natural products such as crops, fish, and vegetables as food in the ceremonies. The social activities related to natural resource management include agriculture activities where during the process, they contact each other as part of the socialization process, particularly within families. The people in Maybrat still hold the traditional culture as stated by many studies that in Papua, most people still conduct the traditional knowledge and activities.

People in Maybrat have the understanding of the benefit of natural resources not only to support the income, but also they have realized the aspects of ecological benefit. For instance, agricultural activities are not conducted close to water catchment areas, lakes, and water sources. This understanding indicates the local knowledge that has been carried out for generations (Murdjoko et al. 2021c; Sonbait et al. 2021). It can be seen that most of the youth (in this research, the age group was below 20 years) has the understanding as the elderly concerning the application of their local wisdom. This wisdom is also implemented in the fishing system in which the local people do not use harmful methods to catch fish in Ayamaru Lake. They believe that the stock of fish must be kept for them and the next generations.

The use of the natural resource for medicinal uses was only perceived by 74 % of informants, that were mainly elderly people. The low dependency of younger people on the use of nature-based medicine in Maybrat is a result of the health facilities by the government. However, they still know the local knowledge of medicinal use of natural resources, such as the application of *Laportea aestuans* (L.) Chew (locally known as *daun gatal*). Yet, for certain diseases, people tend to go to the health service (local known as *pusat kesehatan masyarakat*). In this situation, local people have realized the benefit of health services as the government frequently conducted several health programs in this district. However, it is interesting that even though some of the local people depend on the health service, they still have an understanding of natural resource benefits as medicinal prominence.

In terms of energy prominence, the local people in Maybrat use natural resources by utilizing firewood for cooking and heating even though, in this area, fossil-based fuel is available. The stock of firewood is obtainable as the settlements are surrounded by forests and woodlands, making them easy to get the firewood. In terms of construction prominence, the interesting point here is that most of the houses have been developed using concrete bricks as permanent houses, but local people still depend on the forest to be used as selling places, mainly in front of their houses (Figure 2). Some people also still develop their kitchen using wood as many of them still set the traditional cooking tools using firewood. It means that most of the people in Maybrat still utilize wood to support their trading activities. Even though the market places have been built by the government in a certain area but the local people tend to sell natural products such as the crops close to their place to reduce the transportation cost. This is a habit of most people in Maybrat as they live nearby the streets.

The traditional agricultural practices as the main natural resources management

In agricultural development, there are facilities and infrastructure required, ranging from the upstream segment, on-farm, downstream, supporting services regarding transportation facilities, markets, and credit, as well as supporting institutions. The upstream segment is related to the provision of agricultural production facilities, for example, land, capital, and labor, including technical aspects such as the provision of seeds, fertilizers, and agricultural production equipment. The results of the study indicate that in farming activities, the community so far does not use inputs in the form of fertilizers (both soil and foliar fertilizers). Seeds used by the local people are mainly sweet potatoes and peanuts, which are usually sourced from their gardens; while vegetables and horticulture, such as beans, cabbage, Chinese cabbage, mustard greens, and sweet corn, are mostly purchased at farmer's shops. Agriculture tools used by the community are relatively conventional with limited uses of mechanical equipment for land management, pest/disease control, etc. Agriculture tools are in the form of machetes, sickles, axes used to cut down trees, clear bushes, cut and climb trees, etc.

Farm activities carried out by the local community in Maybrat involve the stages of land clearing, land cultivation, planting, maintenance, and harvesting. Regarding land clearing activities, the community uses shifting cultivation systems with slash-and-burn techniques (swidden agriculture). The formerly cultivated land is left for 3-5 years to experience a fallow period before being re-planted. The Maybrat people understand the recovery cycle during the fallow period, yet there is a lack of scientific information concerning the cycle. Thus, further studies are necessary to assess whether such practice is sustainable or not, particularly regarding the vegetation and soil properties. The fallow vegetation could probably recover naturally, as shown by other studies in Papua (Kuswandi and Murdjoko 2015; Murdjoko 2013; Murdjoko et al. 2016, 2017, 2022; Tawer et al. 2021), yet detailed research focusing on vegetation succession must be executed systematically. Traditionally, the process of agricultural activities is displayed in Figure 3 where the workers are normally family members.

The community usually cultivates peanut as the major crop, along with corn, sweet potatoes, taro johar, and cassava as intercrops. This farming method can be categorized as a mixed farming type. However, in the farming segment intended for peanuts, it is dominated by peanuts, followed by corn, sweet potatoes, bananas, and cassava as intercrops. The farming land is owned individually in the context of a family farm. Our observation noted that no production facilities or equipment are shared by several families.
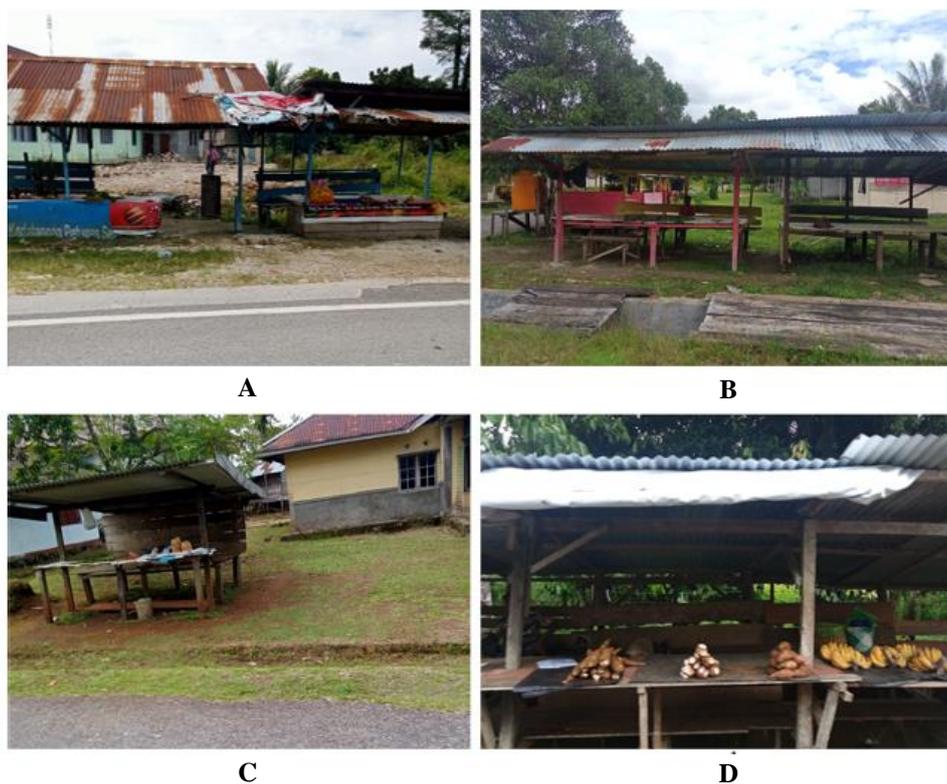
Figure 2. Traditional selling places of crops in Maybrat are built in front of the houses which are nearby the streets
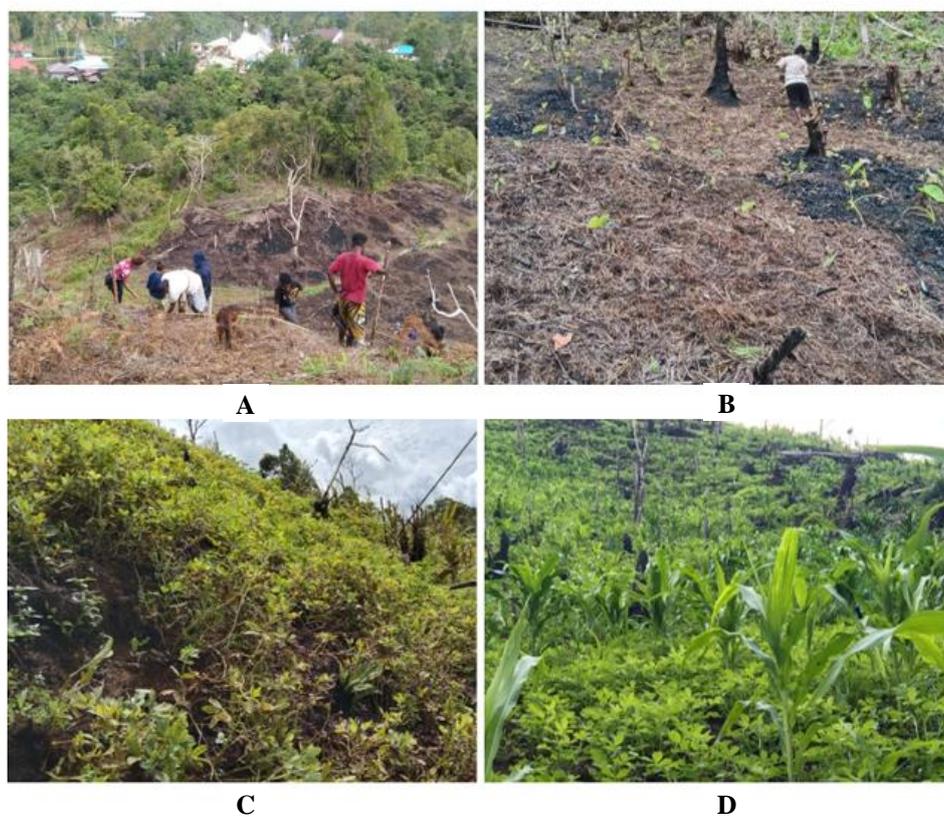

Figure 3. Traditional farming system in Maybrat, West Papua, Indonesia: (A) land preparation by a group of people; (B) planting of crops; (C) growing peanuts; (D) combination of peanuts and corns

For example, there are no hand tractors, hand sprayers, irrigation systems, etc. that are owned and managed jointly by more than one family. In terms of products, the peanut and vegetables are sold for commercial purposes, while other commodities such as sweet potatoes and bananas are for subsistence needs. The downstream agribusiness activities, such as the processing of crops, have not been carried out so far. This means that agribusiness conducted by the community in the form of primary agricultural products, such as peanuts, tubers, vegetables, and fruit, is directly harvested and marketed. This is because supporting services regarding transportation facilities, markets, and credit in the Maybrat District are highly accessible.

The direct market system also happens in the fishing sector, in which the community catches the fish and directly sells in a similar place as the farming crops. Natural products are imperative stuff for people in Maybrat. Therefore, they have conducted the local wisdom to conserve natural resources such as vegetation. In general, local people in Papua still apply the traditional agriculture system using the slash and burn method. Even though they apply swidden agriculture, they have the understanding to preserve the vegetation areas as understood by local people living close to the forest (Li et al. 2014; Manner 1981; Murdjoko et al. 2021a, 2022). Many research has revealed that traditional knowledge is still implemented by people in Papua where natural resources benefit them in their daily needs (Cámara-Leret et al. 2019; Cámara-Leret and Dennehy 2019; Page et al. 2016). In the end, the natural resources in Maybrat gave the benefit local people and they have realized the function of the nature service as explained more by many studies that ecosystem services bring value for livelihood in Maybrat.

Agriculture has been part of social activities for generations in Maybrat. The local people depend on natural resources, particularly agricultural resources. The agricultural products are used for subsistence needs as well as sold commercially. The local people in Maybrat have been conducting their local wisdom to preserve the natural resource by using traditional concepts of agriculture which supports the sustainable management of natural resources. However, monitoring of biotic and abiotic dynamics is imperative to be conducted in the future to contribute scientifically the practical and theoretical information to support development in Maybrat. Hence, development programs by whether the regional or national government could accommodate the local knowledge and gain the goals economically and ecologically. In the end, the anthropogenic approach must be performed in land use management, where local people in Maybrat have been conducting the local wisdom for generations.

ACKNOWLEDGEMENTS

REFERENCES

Burivalova Z, Towsey M, Boucher T., Truskinger A, Apelis C, Roe P, Game ET. 2018. Using soundscapes to detect variable degrees of human influence on tropical forests in Papua New Guinea. Conserv Biol 32 (1): 205-215. DOI: 10.1111/cobi.12968.

Cámara-Leret R, Frodin DG, Adema F. et al. New Guinea has the world's richest island flora. Nature 584: 579-583. DOI: 10.1038/s41586-020-2549-5.

Cámara-Leret R, Raes N, Roehrdanz P, De Fretes Y, Heatubun CD, Roeble L, Schuiteman A, van Welzen PC, Hannah L. 2019. Climate change threatens New Guinea's biocultural heritage. Sci Advan 5 (11): 1-8. DOI: 10.1126/sciadv.aaz1455.

Cámara-Leret R, & Dennehy, Z. 2019. indigenous knowledge of new guinea's useful plants: a review. Econ Bot 73 (3): 405-415. DOI: 10.1007/s12231-019-09464-1.

Castleden H, Garvin T. 2008. Modifying Photovoice for community-based participatory Indigenous research. Soc Sci Med 66 (6): 1393-1405. DOI: 10.1016/j.socscimed.2007.11.030.

Gaveau DLA, Santos L, Locatelli B, Salim MA, Husnayaen H, Meijaard E, Heatubun C, Sheil D. 2021. Forest loss in Indonesian New Guinea (2001-2019): Trends, drivers and outlook. Biol Conserv 261: 109225. DOI: 10.1016/j.biocon.2021.109225.

Indrawan M, Sumule A, Wijaya A, Kapisa N, Wanggai F, Ahmad M, Mambai BV, Heatubun CD. 2019. A time for locally driven development in Papua and West Papua. Dev Practice 29 (6): 817-823. DOI: 10.1080/09614524.2019.1609907.

Kabupaten Sorong. 2020. Kabupaten Maybrat Dalam Angka. BPS Kabupten Sorong Selatan. [Indonesian]

Karous O, Jilani IBH, Ghrabi-Gammar Z. 2021. Ethnobotanical study on plant used by semi-nomad descendants' community in Ouled Dabbeb - Southern Tunisia. Plants 10 (4): 642. DOI: 10.3390/plants10040642.

Khan N, Irshad M. 2022. Socio-economic appraisal of the importance and impacts of Anardana (*Punica granatum* L.) in District Dir Lower Khyber. Ethnobot Res Application 23: 1-18. DOI: 10.32859/era.23.30.1-18.

Kuswandi R, Murdjoko A. 2015. Population structures of four tree species in loggpopulation structures of four tree species in logged-over tropical forest in South Papua, Indonesia: An integral projection model approach. Indones J For Res 2 (2): 93-101. DOI: 10.20886/ijfr.2015.2.2.93-101.

Li P, Feng Z, Jiang L, Liao C, Zhang J. 2014. A review of swidden agriculture in Southeast Asia. Remote Sens 6 (2): 1654-1683. DOI: 10.3390/rs6021654.

Manik H, Yurmiaty H, Asmara IY, Handarto, Iskandar J, Partasasmita R. 2018. Wattled Brushturkey hunting system in the Sigim and Sinaitousi communities in the buffer zone of the Arfak Mountain Nature Reserve, West Papua, Indonesia. Biodiversitas 19 (3): 849-856. DOI: 10.13057/biodiv/d190313.

Manner HI. 1981. Ecological succession in new and old swiddens of montane Papua New Guinea. Hum Ecol 9 (3): 359-377. DOI: 10.1007/BF00890742.

Martins ARO, Shackleton CM. 2021. Local use and knowledge of *Hyphaene coriacea* and *Phoenix reclinata* in Zitundo area, southern Mozambique. South Afr J Bot 138: 65-75. DOI: 10.1016/j.sajb.2020.12.011.

Murdjoko A. 2013. Recuperation of non-commercial trees in logged forest in Southern Papua, Indonesia. Jurnal Manajemen Hutan Tropika 19 (2): 94-102. DOI: 10.7226/jmht.19.2.94. [Indonesian]

Murdjoko A, Brearley FQ, Ungirwalu A, Djitmau DA, Benu NMH. 2022. Secondary succession after slash-and-burn cultivation in Papuan lowland forest, Indonesia. Forests 13 (3): 1-14. DOI: 10.3390/f13030434.

Murdjoko A, Djitmau DA, Sirami EV, Siburian RHS, Ungirwalu A, Mardiyadi Z, Wanma JF, Mofu WY, Marwa J, Susanti CME, Tokede MJ, Imburi CS, Sagrim M, Mamboai H, Sonbait LY, Dwiranti F, Salosa YY, Paembonan JB, Wiradyo ET, Unenor E, et al. 2021a. Tree species diversity of Pegunungan Bintang, Papua, Indonesia as potency of wood supply. Biodiversitas 22 (12): 5665-5675. DOI: 10.13057/biodiv/d221263.

Murdjoko A, Djitmau DA. Ungirwal A, Sinery AS, Herlina R, Siburian, S, et al. 2021b. Pattern of tree diversity in lowland tropical forest in Nikiwar, West Papua, Indonesia. Dendrobiology 85: 78-91. DOI: 10.12657/denbio.085.008.

Murdjoko A, Jitmau MM, Djitmau DA, Mardiyadi Z, Rumatora A, Mofu WY, et al. 2020. Heterospecific and conspecific associations of trees in lowland tropical forest of New Guinea. Biodiversitas 21 (9): 4405-4418. DOI: 10.13057/biodiv/d210960.

Murdjoko A, Marsono D, Sadono R, Hadisusanto S. 2016. Tree association with pometia and its structure in logging concession of South Papua Forest. Jurnal Manajemen Hutan Tropika (Journal of Tropical Forest Management) 22 (3): 180-191. DOI: 10.7226/jtfm.22.3.180. [Indonesian]

Murdjoko A, Marsono D, Sadono R, Hadisusanto S. 2017. Recovery of residual forest ecosystem as an impact of selective logging in South Papua: An ecological approach. Biotropia 24 (3): 230-245. DOI: 10.11598/btb.2017.24.3.732.

Murdjoko A, Ungirwalu A, Mardiyadi Z, Tokede MJ, Djitma DA, Benu NMH. 2021c. Floristic composition of buah hitam habitats in lowland tropical mixed forest of West Papua, Indonesia. Floresta e Ambiente 28 (3). DOI: 10.1590/2179-8087-FLORAM-2021-0042.

Page T, Murphy ME, Mizrahi M, Cornelius JP, Venter M. 2016. Sustainability of wood-use in remote forest-dependent communities of Papua New Guinea. For. Ecol. Manag 382: 88-99. DOI: 10.1016/j.foreco.2016.09.043.

Sonbait LY, Manik H, Warmetan H, Lina Y, Wambrauw D, Sagrim M, Djitmau DA, Wanggai J, Rettob BB, Murdjoko A. 2021. The natural resource management to support tourism: A traditional knowledge approach in Pegunungan Arfak Nature Reserve, West Papua, Indonesia. Biodiversitas 22 (10): 4466-4474. DOI: 10.13057/biodiv/d221040.

Tawer P, Maturbongs R, Murdjoko A, Jitmau M, Djitmau D, Siburian R, Ungirwalu A, et al. 2021. Vegetation dynamic post-disturbance in tropical rain forest of bird's head peninsula of West Papua, Indonesia. Ann Silvic Res 46 (1): 48-58. DOI: 10.12899/ASR-2145

Ungirwalu A, Awang SA, Murdjoko A. 2014. Model aplikasi agroforestri tumbuhan buah hitam (*Haplolobus monticola* Husson) berbasis pengetahuan lokal etnis Wandamen-Papua: Prospek pengembangan perhutanan sosial di Papua. Prosiding Seminar Nasional Silvikultur II : Pembaharuan Silvikultur untuk mendukung Pemulihan Fungsi Hutan menuju Ekonomi Hijau 268-273. [Indonesian]

Ungirwalu A, Awang SA, Suryanto P, Maryudi A. 2017. The ethno-techno-conservation approach in the utilization of black fruit (*Haplolobus* sp.) by the Wandamen ethnic of Papua, Indonesia. Biodiversitas 18 (4): 1336-1343. DOI: 10.13057/biodiv/d180408.

Ungirwalu A, Awang SA, Suryanto P, Maryudi A. 2018. Konstruksi Hutan-Budaya : Skenario Pengelolaan Sumberdaya Alam Adaptif Hasil Hutan Bukan Kayu (HHBK) Berbasis Masyarakat Adat di Papua Barat [Dissertation]. Universitas Gadjah Mada, Yogyakarta. [Indonesian]

Ungirwalu A, Awang SA, Suryanto P, Maryudi A. 2019. Small scale ecology and society: forest-culture of Papua nutmeg. Jurnal Ilmu Kehutanan 13: 114-126. DOI: 10.22146/jik.52091. [Indonesian]

UU 13/2009. Undang-Undang Republik Indonesia Nomor 13 Tahun 2009 Tentang Pembentukan Kabupaten Maybrat Di Provinsi Papua Barat . [Indonesian]