Potential of fruit plants and opportunities for product diversification in Dusung pattern farmers in Wakal Village, Ambon Island

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Abstract. Wanatani or Agroforestry in Maluku is commonly known as Dusung, which is the traditional use of land resources and its ecosystem. This farming system is associated with combining agricultural plants with forestry on a stretch of land, with harvest season numerous kinds of fruits. However, sometimes, these fruits are wasted, damaged, and are left indiscriminately without further processing. Therefore, research related to the distribution of fruit crops per ha, season, and opportunities for product diversification to improve the farming community's welfare is needed. This is a qualitative and descriptive research, with data obtained through observation and interviews to determine farmers' experience and knowledge on fruit crop cultivation and Wakal Village on Ambon Island. The results showed that each household, clan, or family covers an area of 40 ha. Furthermore, there are 10 types of fruit crop products that have economic value with an average of 0.5 - 5 ha of arable land owned by dusung farmers. Therefore, an alternative means of diversifying processed products to increase dusung farmers' income needs to be developed.

1. Introduction

1.1. Background

Agroforestry is a collective name for land-use systems and technologies, where woody perennials (trees, shrubs, palms, and bamboos) are deliberately cultivated on the same land-management units as agricultural crops and animals in some form of spatial arrangement or temporal sequence. It is also an effort to conserve and increase the productivity of natural and forest resources and boost community income. This farming pattern involves the combination of agricultural and forest crops on a stretch of land. However, this concept was developed in order to reduce erosion and maintain soil fertility. Agroforestry is a form of land use that has been promoted worldwide for two and a half decades. It involves the cultivation of woody plants (forestry) either with non-timber crops (agriculture) or grass (pasture) and in certain instances with livestock (bees, fish) to develop ecological and economic interactions between these components [1].

Furthermore, improving the productivity of this system is expected to boost farmers' income and welfare in rural communities [2]. This concept is classified into two systems, namely simple and complex agroforestry. Simple agroforestry is defined as an agricultural system in which trees are intercropped with one or more seasonal crops. These trees are planted as hedges around plots of land
used for food crops or randomly, for example, on an array to form a corridor or fence. Meanwhile, complex agroforestry is a permanent agricultural system that involves several types of trees (tree-based), either planted or naturally cultivated on a plot of land and managed by farmers in accordance with a cropping pattern in order to form an ecosystem resembling a forest area [3].

According to Hatulesila [4], the dusung farming pattern involves the cultivation of productive crops with economic value related to the custom (culture-culture). The dusung farmers usually plant short-term (3-9 months) types of crops, namely vegetables and tubers, while long-term plants are continuously cultivated (1-5 years) as intercrops on the same land. Furthermore, this land's utilization is carried out based on certain aspects of social and physical sustainability. Social preservation implies that all family relatives depend on the long-term crops, which are managed on the dusung land. On the contrary, physical preservation means the existence of plants cultivated in dusung land, which functions as a buffer as well as soil and water conservation to ensure that the ecosystem is properly maintained.

The cropping pattern carried out on dusung land is influenced by the type of plant being cultivated, local culture, and economic opportunities for the farmers. Subsequently, supposing only one type of species is developed, it is referred to as a monoculture. In contrast, when diverse types of crops are cultivated, the cropping pattern is called mixed or agroforestry. There are three agroforestry development objectives. Firstly, it is used to enhance total productivity, such as to increase the product unit and labor output. Secondly, it increases stability by reducing sensitivity to short-term fluctuations, which is realized by spreading risk across the various forest constituents. Thirdly, it boosts sustainability by maintaining long-term productivity through the protection of basic resources [5].

Generally, the potential yields of productive fruit crops from dusung land is excessively much irrespective of the fact that only a few activities are related to the extension, guidance, and application of science and technology by the farmers, thereby occasionally causing these types of plants to either end up completely damaged or unattended because they are not sold in the numerous market centers located in Ambon City. In connection with various efforts to maximize the knowledge and skills of the farmers in Wakal Village, it is appropriate to carry out an integrated coaching and mentoring initiative starting with counseling activities, to foster farming as well as processing techniques for manufacturing other products such as fruit juices, jams, and sweets for the home industry scale (home industry).

1.2. Research problems
The study showed that the monoculture cropping system for seasonal plants or food in the long term caused a decrease in land fertility, which ultimately led to a decrease in yearly crop production. Meanwhile, the annual planting of certain types of crops or trees aids in maintaining and increasing soil fertility through the recycling of nutrients [6]. This condition shows that agroforestry plays an extremely important role in environmental conservation because the structure of the formed vegetation has unique properties resembling secondary forests or agroforests, thereby boosting energy and the circulation of nutrient material to enhance soil fertility and plant productivity.

The method of implementing double planting on a stretch of land, either in the form of complex or simple agroforestry practices, is one of the traditional farming patterns adopted by several generations of people residing in Central Maluku (Ambon, Seram, and Lease Islands) and it is referred to as dusung. This farming pattern is perceived as a legacy since ancient times. This practice starts with clearing the land to prepare tuber gardens in the form of crops, plantations, and other types of forestries realized in accordance with climate change. However, during the dusung farming, harvesting is carried out based on different time intensities, for example, either several times or once in a year, although, this is extremely dependent on climatic conditions and the season of the plant from flowering till when it is ripe for this fruit crop to be harvested. In addition, it usually has a different harvest time [7].

The intercropping of fruit crops, namely coconut, with spices such as nutmeg, cloves, and sago, including food plants such as vegetables, tubers, pineapples, and bananas, is a transition system from natural forest to a pattern of fruit tree plantations - ingredients or spices. The settling system for coconut, tubers, and banana is a practice that no longer requires shifting cultivation, and farmers have to live off the fields. The dominant sweet potato species are sweet potato (Discorea alata), kembili (Discorea
Cassava (Colocasia esculentum), sweet potato (Colocasia esculentum), Xanthosoma sagitifolium, and Alocasia spp. Conversely, carbohydrate-producing bananas are mainly categorized as those that belong to the plantain group (AAB and ABB) rather than the banana group type (AA and AAA). The dusung system on Ambon Island adopted a cropping pattern which consists of walnuts, coconut, cocoa, and nutmeg. It is suitably referred to as an agroforest, while a combination of pomoforest or pomologiforest fruit trees (fruit trees) is profitable for farmers in dusung farming [8].

The classic problem experienced by dusung farmers is the abundance of various productive fruit plants that exceed the market capacity during the harvest season, thereby resulting in great losses. This is because certain quantities of harvested fruit crops are always wasted and not sold in the market. Presently, no effort has been adopted to diversify products to household industries. Therefore, it is necessary to provide guidance and assistance in the form of training for home industry business groups to diversify packaged snack products from its basic ingredients of abundant fruits during the harvest season.

2. Research methods

2.1. Research place and location
The research location was carried out on dusung land owned by farmers in Wakal Village, Leihitu District. This village has a fruit crop business pattern based on the dusung farming habits and in accordance with the home industry group, which has produced and marketed packaged products.

2.2. Research approach
This is a qualitative research, which consists of background problems, identification, and formulation. A total of 30 heads or farmers were selected through the purposive sampling method, with data collected by determining the types of fruit crop products and plants cultivated in the area. The sampling method depends on the morphological conditions of the plant species and their distribution.

2.3. Types of tools and data sources
The type of tools used during the data collection process in the field include Questionnaires, recording devices, cameras, sheet straps, a set of computer software, and writing instruments. The sources of data acquired are related to land conditions, agroforestry cropping patterns, fruit crop yields, and labor costs.

2.4. Data collection technique
Data collection was carried out by direct observation to obtain information based on this study's aims and objectives. Interview technique includes questions and answers by respondents with the aid of a questionnaire and literature review.

2.5. Data analysis
The method used to analyze dusung farming land management orientation is based on the following criteria: individual, social, and environmental values. Individual value orientation (egotistical value) focuses on maximizing their income, which is realized by analyzing the types of fruit plants cultivated and the adopted farming patterns. Social (altruistic) values emphasize the group's welfare, which is analyzed based on land exploitation objectives. It is also related to the dusung farming pattern adopted, as well as concern for solidarity and the development of groups or community members. Ecological (biosphere) values emphasize environmental conservation efforts, which are analyzed based on perceptions, attitudes, and assessments related to approaches that need to be sustained in accordance with dusung-style farming land use activities.

3. Discussion

3.1. Land use system in Dusung farming in Wakal Village
Land management in accordance with a sustainable agroforestry system, is expected to boost overall land productivity. Agroforestry is perceived from two aspects, namely vegetative and economic
potentials. The vegetative potentials include both timber and non-timber forest products. On the contrary, the economic potential is perceived from the economic value of agroforestry products manufactured from existing systems [9]. Generally, the land use of the research location in Wakal Village or State is grouped into several types, namely, forest, moor, plantation, settlement as well as other uses. The survey results and identification of land use in the study location are shown in the following Table 1.

Table 1. Land use and plant patterns.

| Study Locations | Type of Land Use                           | Plant Type Pattern        | Area (ha) |
|-----------------|-------------------------------------------|---------------------------|-----------|
| Wakal Village   | Secondary forest, moor, mixed garden, open land, and settlements | Crops                      | 0.1 - 0.2 |
|                 |                                           | Fruit plants               | 0.5 - 5   |
|                 |                                           | Forest plants              | 0.2 - 10  |
|                 |                                           | Monoculture of Clove       | 1 - 10    |
|                 |                                           | Monoculture of Nutmeg      | 1 - 5     |
|                 |                                           | Monoculture of Sago        | 0.2 - 0.5 |
|                 |                                           | Monoculture of Cocoa       | 0.2 - 4   |
|                 |                                           | Monoculture of Salak       | 1.5 - 5   |

Description: Size based on respondent information.
Source: Data Analysis Results.

Specific land use is, in accordance with the technical requirements of a location-based on certain physical and socio-economic conditions, for example, rain-fed food crops, management of livestock with only one type of crop or a combination of several others, and this is referred to as agroforestry [10].

The dusung pattern is usually based on the land’s characteristics and the landscape’s carrying capacity, which is closely related to the physical environment, namely climate, topography or relief, hydrology, and the state or type of vegetation adopted by farmers. The pattern of plant types in a simple agroforestry system is usually dependent on land use, which is carried out by deforestation, clearing by slashing, burning, and then leaving it for some time. In addition, the process of planting turns out to resemble mixed gardens [11].

3.2. Area and distribution of fruit plants in Wakal Village
The Wakal Village Area is located on the North Coast of Ambon Island, in Jasirah Leihitu. The location used for agroforestry is not far from residential areas ± 500 to 1000 meters, with fruit tree species distribution, as shown in table 2.

Table 2. Ownership of area and distribution of fruit plants.

| No  | Ownership of Dusung | Area (ha) | Potential Types of Fruit Plants                                      |
|-----|---------------------|-----------|---------------------------------------------------------------------|
| 1.  | Matarumah Suneth    | 12        | Bicang, Guava rutong, Durian, Nutmeg, Langsat, Mangosteen, Coconut, Duku, Rambutan, Avocado, Kecapi, Tomi-tomi, Salak, Pineapple Breadfruit, Mango, Kedondong, Banana, Kuini, Petai, Gayang, Cashew Nut, Walnut, Kakusang, Sweet Starfruit, Jackfruit, Soursop, Cempedak, Papaya. |
| 2.  | Matarumah Uweng     | 10        |                                                                      |
| 3.  | Matarumah Patah     | 8         |                                                                      |
| 4.  | Matarumah Makatita  | 6         |                                                                      |
| 5.  | Matarumah Mahu      | 4         |                                                                      |

Amount 40

Source: Respondent Data Analysis.
The data in table 2 shows that Suneth dusung maturumah occupies 12 ha of land, which is the largest area used for fruit plant species, followed by the Uweng sunk, Patah maturumah, Makatita maturumah, and Mahu maturumah occupying areas of 10 ha, 8 ha, 6 ha, and 4 ha respectively. This shows that Wakal Village has promising fruit trees, including the potentials to be properly cultivated every season. Therefore, this research's subject is centered on whether the lands used for the cultivation of fruit crops tend to be properly managed by the respective owners. Based on the various types of fruit plants, this potential needs to be managed productively in order to boost the selling value. These fruit trees are generally distributed on different slopes ranging from 0.0% to less than 40%. This is represented based on the topographical conditions of the Wakal village, which consists of flat areas and slightly steep slopes.

3.3. Potential of fruit-producing trees

Increased land use conflicts need the adoption of agricultural production systems in accordance with a variety of ecosystem services, namely climate change mitigation. Globally, agroforestry is described as one of the solutions to improve land-use efficiency, as well as to reduce environmental impacts and economic risks for farmers [12]. According to the survey results, including the identification of potentials related to the different plot samples, the 5 respondents that owned the largest dusung farms in Wakal Village showed that the fruit-producing plants cultivated by the local community were generally diverse. The average distribution of tree species per hectare was approximately 5.81 tree/ha, as shown in the following table.

### Table 3. Tree potential per hectare of fruit plant types.

| No. | Dusung | Potential (tree/ha) | Types of fruit plants in Dusung |
|-----|--------|---------------------|---------------------------------|
|     | Ave    | SE*                |                                 |
| 1.  | Suneth | 5.58 2.10          | Nutmeg. Langsat. Mangosteen. Coconut. Gandaria. Duku. Rambutan. Bicang. Guava rutong. Durian. Pineapple. Cempedak. Papaya. Breadfruit. Mango. Kedondong. Kuini. Kenari. Jackfruit. |
| 2.  | Uweng  | 4.42 1.15          | Bicang. Guava rutong. Durian. Nutmeg. Langsat. Mangosteen. Coconut. Gandaria. Duku. Rambutan. Avocado. Kecapi. Tomi-tomi. Pineapple. Breadfruit. Mango. Kedondong. Banana. Kuini. Petai. Gayang. Cashew. Walnut. kakusang. sweet starfruit. jackfruit. soursop. cempedak. papaya. |
| 3.  | Patah  | 2.53 0.50          | Cempedak. Gandaria. Duku. Papaya. Guava rutong. Durian. Nutmeg. Langsat. Mangosteen. Coconut. Rambutan. Pineapple. Mango. Banana. Walnut. |
| 4.  | Makatita | 2.25 1.40    | Guava rutong. Durian. Nutmeg. Langsat. Mangosteen. Coconut. Gandaria. Duku. Rambutan. Avocado. Kecapi. Pineapple. Mango. Kedondong. Walnut. Kakusang. |
| 5.  | Mahu   | 1.15 1.12          | Durian. Nutmeg. Langsat. Mangosteen. Coconut. Gandaria. Duku. Kuini. Gayang. Kenari. Latrine. Rambutan. Bicang. Guava. Avocado. Kecapi. Tomi-tomi. Pineapple Jackfruit. Soursop. Cempedak. Papaya. Breadfruit. Mango. Kedondong. Banana. Star fruit is sweet |

Average 15.01

Note: SE* = Sampling Error.
Source: Data analysis results.
Subsequently, the dusung belonging to the eye of the suneth house has the greatest potential, which is approximately 5.58 phn / ha, followed by that belonging to the Uweng family, which was ranked second, with relatively 4.42 phn / ha ranks second. The dusung owned by the Patah, Makatita and Mahu families are 2.53 phn/ha, 2.25 phn/ha, and 1.15 phn / ha, respectively. Furthermore, the distribution of fruit tree species is largely determined by the area of these dusung farms. The slightly intensive cultivation process was traditionally carried out, thereby causing the potential existence of this type of fruit plants to be highly dependent on climatic conditions. The aspects of farming methods or approaches adopted by the dusung farmers are generally carried out based on their customs and traditions.

Farming activities in the Wakal Village community are carried out on land privately owned by each clan or family. The dusung pattern, which is based on ownership is divided into two, namely dusung heirloom and dati. The dusung heirloom is described as the farmland, owned and inherited by the offsprings, particularly the males that bear the clan name. Conversely, the dusung dati is owned based on the kinship relationship between the concerned clans. This form of ownership has been passed down from generation to generation and handed over through a procession of customs [13]. The 5 matarumah kinship system, which has the largest hamlet in the village, serves as a measure of maintaining and developing potential fruit plants that positively impact the life of the local community.

The number of fruit trees cultivated in each dusung showed that the diverse species are unevenly spread and generally similar to its ownership and management. In addition, the decision making process is strongly influenced by the owners, therefore regulating the existence of the various types of plants and the number of trees is not only determined by a particular individual rather a joint meeting which depends on the type of kinship relationships needs to be performed [14]. The potential types of fruit plants, generally developed in community-owned dusung in Wakal Village, are shown in the following table 4.

**Table 4.** Potential types of fruit plants developed according to land use types

| Type of Land Use    | Potential (tree/ha) | Types of fruit plants                               | Cultivation land ownership |
|--------------------|---------------------|-----------------------------------------------------|-----------------------------|
|                    | Average             | Coconut. Durian. Nenes. Nutmeg. Duku. Langsat.      | Sunet. Uweng. Patah.        |
|                    |                     | Gandaria. Rambutan. Banana. Jackfruit. Soursop.      | Makatita. Makatita. Patah.  |
| Mixed Garden       | 6.89                | Cempedak. and Papaya.                               | dan Mahu                   |
| Coconut Plantations| 6.04                | Inner Coconut                                       | Patah. Makatita. dan Mahu.  |
| Nutmeg Gardens     | 5.05                | Nutmeg of Banda. Nutmeg of Ambon. Nutmeg of Seram   | Sunet. Uweng dan Mahu       |
| Salak Gardens      | 2.10                | Salak Mondo. Salak Ambon. Salak Bali                | Sunet. Uweng dan Mahu.      |
| **Average**        | **5.02**            |                                                      |                             |

Note: SE* = Sampling Error
Source: Data Analysis Results

Table 4 shows that the number of fruit tree species cultivated by each family using the dusung pattern averaged 5.02 trees per / ha, and they generally have a high selling value in the market. However, because the production of fruit trees was centered on land use, the data obtained showed that each harvest had different results. Based on these conditions, it is guaranteed that the potential for spreading these types of fruit plants is presumed to be adequate for their growth and development.

Therefore, it is still possible for the area to be developed and used as fruit plant agroforestry centers. Subsequently, it also serves a dual function, such as a buffer (bafer) for the preservation of germplasm,
flora, and fauna, as well as a zone for water systems in the Wakal Village. This proves that multi-stratified agroforestry systems contribute to the conservation of tropical biodiversity. However, there is an ongoing debate regarding the comparison of biodiversity, intact forest, and alternative land uses [15].

3.4. Potential of fruit production in Wakal Village

The economic activities of the people in Wakal Village are mostly centered on the dusung. The indigenes are mostly farmers that cultivate fruit plants, namely durian, gandaria, langsat, mangosteen, langsat, duku, nutmeg, banana, coconut, and pineapple. The data obtained from the interview concerning the types of productive fruit plants that contributed to the dusung are shown in the following table.

**Table 5. Types of marketed fruit plants.**

| Type Plant Fruit | Harvest value each season (Year) | Market Location | Product Diversification |
|------------------|---------------------------------|-----------------|-------------------------|
|                  | Sack Tie it up | Unit Price | Value (IDR) | District City | City District/ Province |                     |
| Salak            | 10-25 200,000 | 5,000,000 | Wayame | Ambon | Sweets |
| Durian           | 50-100 100,000 | 10,000,000 | Wayame | Ambon | Dodol |
| Langsat          | 5-50 5,000,000 | Wayame | Ambon |          |
| Mangosteen       | 5-20 200,000 | 4,000,000 | Wayame | Ambon |          |
| Duku             | 5-25 200,000 | 5,000,000 | Wayame | Ambon |          |
| Pineapple        | 50-200 25,000 | 5,000,000 | Wayame | Ambon | Jams   |
| Rambutan         | 10-300 10,000 | 3,000,000 | Wayame | Ambon |          |
| Coconut          | 10-50 50,000 | 2,500,000 | Wayame | Ambon | Cooking oil |
| Nutmeg           | 5-20 250,000 | 5,000,000 | Wayame | Ambon | Sweets |
| Banana           | 100-200 7,500 | 1,500,000 | Wayame | Ambon | Banana cake |

Source: Data analysis respondent.

The results from the table shows that only ten types of fruit products are a mainstay in the market. It also shows that each respondent's average profit in a land area of approximately 1 to 2 ha where the 10 types of plants are cultivated is quite good. Some of them are sold at fruit stalls by the roadsides and at the market in Ambon City. According to Thomas [16], the development of dusung encompasses various types of vegetation such as Eugenia aromatica, Durio zibethinus, Lansium domesticum, Bouea macrophylla, Gmelina molucanna, and Myristica fragrans, as well as fertile soil and an easy-to-reach location or accessibility. It also consists of opportunities, namely a marketing aspect that positively impacts income generated for the community. This is consistent with the research carried out by Fouladbash and Currie [17], which reported that households that indulge in tree planting had increased income diversification while those that adopt agroforestry practices have improved food security. Based on the results from the interviews with respondents related to excess production, it was reported that out of the numerous fruit plants, only 6 types are usually converted into other products because this habit has been carried out from generation to generation by the dusung farmers.

3.5. Alternative diversification of fruit plant products

The local communities often market fruit plant products, however, it is affordable for buyers that come to the garden. According to the interviews, the dusung farmers stated that they realized abundant yields in certain instances despite achieving poor sales. The cause of this abundance was not only realized in the orchards, it also has an impact on the market because it was not sold out. It is also an inconvenience to the dusung farmers because their ability to process them into other products is limited due to a few
equipments and lack of labor for advanced processes. These various obstacles are often experienced by people that own fruit dusung in Wakal Village.

Conversely, when the aforementioned problems were closely observed, an alternative business development that is realized through the diversification of abundant fruit harvests during each season and prohibits the farmers from encountering losses was initiated. The form of product diversification from processed snacks to other packaged products is shown in the following table 6.

**Table 6. Diversification of processed products from types of fruits.**

| Types of processed products | Processed materials | Types of fruits for processed products |
|-----------------------------|--------------------|---------------------------------------|
| Chips                       | √                  | Jackfruit, Breadfruit, Kuini, Salak, Cempedak |
| Jam                         | √                  | Pineapple, Gandaria, Tomi, Mangga, Kuini, Bacang, Papaya |
| Sweets                      | √                  | Pineapple, Gandaria, Tomi, Mangga, Kuini, Bacang, Papaya |
| Dodol                       | √                  | Durian, Soursop                       |
| Syrup                       | √                  | Salak, Pineapple, Gandaria, Tomi, Mango, Soursop |
| Juice                       | √                  | Salak, Mango, Guava, Gandaria, Soursop, Rambutan, Avocado |
| Fluor                       | √                  | Salak, Mango, Bicang, Kuini, Coconut, Rambutan |
| Sugar                       | √                  | Coconut, Enau                        |
| Oil                         | √                  | Coconut                              |
| Asaman                      | √                  | Tamarind, Gandaria                   |
| Salad                       | √                  | Salak, Mango, Kedondong, Guava, Papaya, Pineapple, Nutmeg |
| Petis /Sambel               | √                  | Tamarind, papaya                     |
| Paste                       | √                  | Tamarind, Papaya                     |
| Cakes                       | √                  | Salak, Banana, Cempedak, Jackfruit, Breadfruit |
| Soy sauce                   | √                  | Papaya,                               |

Source: respondent data identification.

Based on the results from the identification of fruit that are processed into other products, an alternative diversification centered on skill development for the owners was adopted. However, the assistance, guidance, and training activities for the fruit-producing farmers in Wakal Village need to be improved through productive small business groups by searching for market opportunities to boost family income, both from the sale of fruits and processed food packaging products. Therefore, the support of various parties, particularly government and private institutions such as the Center for Industry and Small Business and other Non-Profit Institutions, is fostered to aid in the dusung farming pattern’s progress Wakal Village.

4. Conclusion

1. The largest fruit plant species in the Wakal Village, which covers an area of 12 ha, is owned by Suneth Suneth, followed by Uweng Matarumah, Mata Rumah Patah, Matarumah Makatita, and Matarumah Mahu with areas of 10 ha, 8 ha, 6 ha, and 4 ha, respectively.
2. The productive fruit crops, namely zalacca, durian, langsat, duku, pineapple, rambutan, coconut, nutmeg, and banana, are generally cultivated in dusung each season due to their economic value.
3. The alternative product diversification of the several types of snack products such as chips, jam, sweets, lunkhead, syrup, juice, flour, sugar, oil, acid, salad, paste or sambal, shrimp paste, soy sauce, and various cakes that are sold in the market are derived from the various fruit plants.

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