Interaction of integrating land use systems on pig farming systems, West Papua-Indonesia; worth or worse?

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Abstract. In the pattern of livestock keeping systems, livestock can have free access path to natural resources such as forests, scrubs, water, natural shading, wastes, and residues. How they use and do interact with land use systems particularly the pigs, become the focus of this assessment. the study areas will cover four districts, i.e. Warmare, Prafi, Masni and Sidey. The total areas of study therefore is 1,022.67 km² (102,266.54 ha). Data collected from BPS board of Manokwari, Papua Barat. Data were analyzed using Statistical descriptive and shown in tables. Pictures were drawn using Arc GIS and Microsoft Visio. There are 11 types of land use systems which have roles in ecosystem and livestock-human interaction. Land use was dominated by tropical forest and followed by oil palm plantation, communal land, transmigrate areas and arable land. Beef cattle present dominantly the land use systems in agro-complex of Prafi, followed by pigs and goat. Further study is needed to prove the effect of interaction on sustainability indicators, i.e. society, economic and environment.

1. Introduction

The needs for converting lands into various development objectives and usages in developing countries are not questionable. Every space has important meaning when other users need. Competing lands between human and animals and the roles of landscape cannot be refused. In developing countries such as Indonesia, animal agriculture such as cattle, goat and sheep and pigs can have free space for maintaining their natural living activities. This pattern of livestock rearing is called by free-range or scavenging livestock farming systems, similar to extensive livestock system.

In the pattern of livestock keeping systems, livestock can have free access path to natural resources such as forests, scrubs, water, natural shading, wastes, and residues. In one hand, pigs as non-ruminant will have access to underground small animal such as crustacean, bird eggs, and underground animals. The types of natural resources exist in a vast number of width (hectares) are tropical forest. Other typical natural resources are secondary forest and oil-palm trees. Oil-palm trees called by definition is human-made habitat. This oil palm plantation has been defined as major threat for biodiversity losses [1]. Malaysia and Indonesia are amongst the two largest oil palm trees plantation in the world. Under this environment, integrated livestock farms are developed both in intensive and extensive ways. Not only man rearing livestock, there are also free-range livestock and feral even wild animal living under these specific habitats. The one is pigs. Under tropical oil palm plantation, hybrid-, local- and wild boars can have similar changes inhibiting even competing areas in terms of available resources.
With its typical behavior, pigs are one small herbivorous, mono-gastric and non-ruminant animal agriculture that is strongly dependent on this type of habitats. It is therefore, some pig populations are found under oil palm plantation. They can freely have access to resources available under canopy of oil palm trees [2]. As reported that oil palm canopy has shaped local surface temperature suitable needed by animals, such as wild animals and pigs [3]. The denser of the canopy will have effect on dynamic of local surface temperatures and humidity. Besides, having chances to agriculture land areas, homestead, and household gardens. This is a short of how pigs can extend and expand its population both in human made agriculture and plantation and under natural forests. How extend pigs occupying and using such fields and how do the field support the pigs are now questionable. It is assumed that in agriculture and plantation, food will available and sufficient to assure the growing population of the pigs. Likewise, natural forest will have shortages of food to provide growing number of pigs. This is in line with [4] which stated that pigs will affect soil carbon dioxide emission in hardwood forest, Switzerland and in turn reduces soil organic matter. Soil organic matter is an indication of soil fertility. Therefore, the pigs will use wide areas (home range) to seek the food. Understanding good interaction between pigs with human made habitat and natural habitat will determine suitable future developing livestock farming systems.

2. Materials and Methods

Astronomically, Manokwari Regency is placed under equator line, between 0° 14’ S and 130° 31’ E. The geographical boundaries of Manokwari Regency are West is Tambrauw Regency, North is Pacific Ocean, East is Pacific Ocean and South is Teluk Pegunungan Arfak and Manokwari Selatan Regency. Manokwari Regency is divided into 9 districts, which total area are 4,650,32 Km².

![A spatial map of study areas used to determine the boundaries of study.](image)

These areas of study were selected by the reasons that the areas have been used widely for several kinds of usages, i.e. plantation, transmigrate/urban areas, arable land, communal land, and livestock production. Human made areas tend to limiting and disturb the natural population of pig production. From the figure above, the study areas covered four districts, i.e. Warmare, Prafi, Masni and Sidey. The total areas of study therefore is 1,022.67 km² (102,266.54 ha).
Data were analyzed using Statistical descriptive and shown in tables. Pictures were drawn using Arc GIS and Microsoft Visio.

3. Results and discussions

3.1. Trees (Agro-silvo pasture) habitats
In the third world like Indonesia, tropical land uses are still shifted. The lands are being converted into various land uses for production. The one is for planting oil, palm fruits (*Elaeis guineensis*). *Elaeis guineensis* is the first-fifth top crops grown in Indonesia besides, cereals, rice/paddy, root and tubers and sugar cane.

Table 1. Typical Landuse and size of areas in Manokwari, Papua Barat.

| Land use in Manokwari          | Area (Ha) | Area (km²) | Proportion (%) | Notes                          |
|--------------------------------|-----------|------------|----------------|-------------------------------|
| Ponds                         | 116.86    | 1.17       | 0.11           | -                             |
| River                         | 1,580.98  | 15.81      | 1.54           | -                             |
| Tropical forest               | 65,765.46 | 657.65     | 64.31          | -                             |
| Oil palm plantation           | 23,689.65 | 236.90     | 23.16          | Conversion / Land Use Changes |
| Grassland                     | 1.65      | 0.02       | 0.0016         | -                             |
| Pasir / Bukit Pasir Darat     | 866.84    | 8.67       | 0.85           | -                             |
| Pasir / Bukit Pasir Laut      | 138.22    | 1.38       | 0.13           | -                             |
| Arable land                   | 2,142.78  | 21.43      | 2.09           | Transmigrate settlement area   |
| Transmigrate areas            | 2,172.37  | 21.72      | 2.12           | Transmigrate settlement area   |
| paddy field                   | 794.56    | 7.95       | 0.78           | Transmigrate settlement area   |
| communal land                 | 4,997.15  | 49.97      | 4.88           | Transmigrate settlement area   |
| Total Area Study              | 102,266.54| 1,022.67   |                |                               |

According to FAO, there are several countries having very vast growing oil, palm fruits, i.e. Indonesia, Malaysia, Thailand, Nigeria, Columbia and Ecuador. Still figure of oil, palm fruits based on head and tons grown in Indonesia according to FAO showing increasing number in year 2011 to 2013, i.e 13,516,368 heads (743,400 tons), 13, 958,443 (767,714 tons). Counted as well that in the world, Asia’s oil, palm fruit production shared 86.1% higher than that of Africa (7.2%), Americas (5.8%) and Oceania (0.95). In Indonesia, like published by FAO, area harvested of oil, palm fruits and its production has been increasing, i.e. from 6,170,000 (2011) to 9,333,482 ha and produced 105,000,000 tons (year 2011) to 160,135,795 tons (year 2016).

Agro-silvo pasture habitat is commonly found in the world. Before agro-silvo pasture has been practiced, the land areas had been grown dominantly by forest tress. In several decades, the demand of human needs increased in number and varieties, i.e. food, feed and fuel [5]. Besides for feeds for animals both livestock and fisheries, the needs have been increasing in non-feeding demands, such as soap and detergents [6].

Of the figure, the length sizes of land use in study areas are dominated by tropical forest (64.31%), followed by oil palm plantation (23.16%), communal land (4.88%), transmigrate areas (2.12%), arable land (2.09%), and river (1.54%). The rest of less than 1.00% is occupied by ponds (0.11%), grasslands (0.0016%), terrestrial empty land (0.85%), coastal empty land, paddy field (0.78%). Ponds are located inside forest covers areas. Besides, ponds and small lake can be seen closed and around
the main road and communal land. Ponds can support water temporary for pigs and other livestock as well as wild animals. In one hand, ponds can be used by human to catch fishes. There are rivers that flow through the areas. The rivers are named Warmare-, Prafi-, Masni- and Sidey rivers. The rivers as well are used by animal as sources for drinking water, seeking food and nesting sites near water sheet areas.

![Figure 2. Typical land use areas in four main districts, Manokwari-West Papua](image)

Oil-palm plantation has been grown in four districts, i.e. Warmare, Prafi, Masni and Sidey. Total areas of oil palm are 350,000 ha. Beside, land size where paddy is grown is 3144.83 ha, followed by mays 1334.67 ha, and taro 475.26 ha.

3.2. Prafi lowland of agro-complex plantation
It is common under tropical livestock farming systems seen livestock including pigs tethered and scavenging around arable land, plantation and communal lands. The livestock indeed have certain daily activities. The herds of cattle, goats and pigs are released and accompanied to seek the feeds in terms of forages on various land use systems. The livestock as well as pigs share similar and mutual places to use spaces and resources. Beside penned in animal houses, livestock and pigs also release into lands nearby. They can feed crops, residues, herbs, shrubs, underground plants and as well as underground animals. To what extend livestock and pigs can feed from every land use systems is unclear yet.

Transmigrate areas are established as well in this area. This valley is being developed for agro-politiant. The land is available, access is ease as possible, markets are available, and housing for households exist. Therefore, the areas are recognized as agro-complex. It can be seen that, human access and interaction daily with natural resources are unquestionable.
Oil palm plantations have a predominantly negative net effect on ecosystem functions when compared to primary and secondary rainforest (figure 4). Net effects do not imply that all effects on a given ecosystem function are positive or negative, but that the majority or most-dominant effects are in the given direction. Estimates of net effect direction and correlation are qualitative and are based on the summary presented herein.

3.3. Small-scale pig (livestock) farming systems

Small-scale livestock farming systems in Asian have been dominated by household scales. Farmers keep their livestock in small number of heads to assure the production and economic cycles. Most farmers in West Papua are raising pigs in rural areas. In fact, farmers also use existing local feeding sources to feed their animals. Mostly crops and its residues. Cattle, goat and village chicken are the first three animal agriculture kept by small-scale farmers in the world. Not only in Asia, Africa and America continents as well have depended their livelihood sources on livestock farming systems. In Indonesia, as a part of Asian countries, livestock though has been kept by small-scale farmers.

Farmers in Indonesia have living bank stock, i.e. livestock (table 2). Those animal agricultures must produce some cashes to fulfill farmers’ basic needs. The roles of livestock in Indonesia is tightly linked with agriculture and its surrounding environment. It is due to agriculture products and its surrounding environment resources. Agriculture production in Indonesia is such as paddy, cassava, vegetables and other horticultures. While production of surrounding environmental resources can be resulted from plantation, secondary forest and primary forest. Agriculture products and its surrounding environment also provide comfort areas for livestock to roam around, browsing forages and scavenging foods. These two typical areas become clear habitat for livestock to make their life continues there. These typical habitats are the picture of now a day’s landscapes in the world.
Table 2. Population of livestock reared and belongs to farmers (Village/Farmer)

| Parameter                      | District       | Warmare | Prafi     | Masni | Sidey |
|-------------------------------|---------------|---------|-----------|-------|-------|
| Population (Head)             |               |         |           |       |       |
| Beef                          |               | 3972    | 5618      | 2611  | 5289  |
| Goat                          |               | 910     | 2482      | 2657  | 843   |
| Pigs                          |               | 3795    | 4793      | 4037  | 3259  |
| Pop./Village (Head/Village)   |               |         |           |       |       |
| Beef                          |               | 220     | 351       | 194   | 441   |
| Goat                          |               | 50      | 155       | 83    | 70    |
| Pigs                          |               | 210     | 299       | 126   | 272   |
| Pop./farmer (Head/Farmer)     |               |         |           |       |       |
| Beef                          |               | 6       | 2         | 9     | 3     |
| Goat                          |               | 1       | 1         | 62    | 4     |
| Pigs                          |               | 8       | 1         | 16    | 30    |

Source: Regency Statistical Board of Manokwari, Papua Barat Province.

It is clear now a day that in Asia countries such as Malaysia and Indonesia as the biggest oil palm plantations producers [7,8], integrating livestock inside the plantation become win-win solution to make plantation worth for farmers. Livestock can have spaces and resources their searching for. The livestock release and tied inside and close by the plantation. Therefore, livestock indeed have access to other areas such as secondary forest, farming land and primary forest. Not only ruminant animals, such as cattle and goat as well as the sheep, non-ruminant animal such as horses and pigs as well have places inside and under plantation. Plantation in Indonesia presents in several provinces such as Sumatera, Borneo, Java, Sulawesi, and Papua. In Papua, there are two and longest plantation areas, i.e. Jayapura and Manokwari.

In Manokwari, tropical pig farming system exist. Recent study succeeds classifying tropical pig farming systems into four systems [9]. The important and tied tethered pig farming practiced by local Papuan farmers is free-range (scavenging) pig farming system. In this system, farmers release the pigs around the household backyard, garden, communal land, secondary and primary forests, watershed rivers, and even inside the oil palm plantation. Therefore, pigs reared under oil palm plantation is called by “oil palm-pig” [10]. Pigs can have choice to select various typical land use systems in planning pig’s production cycles.

4. Conclusion
There are several primary types of land use systems which have roles in ecosystems and livestock-human interaction. Land use was dominated by tropical forest and followed by oil palm plantation, communal land, transmigrate areas and arable land. Beef cattle present dominantly the land use systems in agro-complex of Prafi, followed by pigs and goat. Further study is needed to prove the effect of interaction on sustainability indicators, i.e. society, economic and environment.

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