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Agricultural innovations and adaptation strategies among upland communities in the state boundary of Kupang District (Indonesia) and Oecusse Enclave (East Timor)

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Abstract. *Ngongo Y, Markus JER. 2020. Agricultural innovations and adaptation strategies among upland communities in the state boundary of Kupang District (Indonesia) and Oecusse Enclave (East Timor). Trop Drylands 4: 51-57.* The policy pledge of 'development started from the periphery' has been implemented as a new paradigm of national development in Indonesia. Agricultural Ministry translated this national policy by implementing several programs and one of them is promoting agricultural innovations to boost agricultural production and rural development in the state boundary. This paper elaborates on agricultural innovations being introduced and adaptations of local people towards harsh climate and to protect natural resources in the state boundary of Kupang District of Republic of Indonesia and Oecusse enclave of Republic Democratic of Timor Leste (East Timor). Data and information are used mainly from the on-going program of Agricultural Innovation Support (AIS). Some insights of similar programs implemented in the three other districts of Timor that share borderlines with East Timor have also been used to enrich the narratives. The study shows that agricultural innovation being introduced has successfully been adopted by co-operators, however, it has limited impacts on the surrounding farmers/villages due to farmers' poor access to the external inputs market, and agricultural extensions. This implies that agricultural innovations should consider farmers' circumstances, particularly harsh climate of the region, and it should compatible with household calendar both in farming and off-farming particularly in honey harvesting. Traditional beekeeping by Amfoang community demonstrates how local people maintain one of the important sources of their livelihoods and at the same time protect natural resources. Recognizing and supporting customary law on honey harvesting helps protect forests and biodiversity in Amfoang and Timor in general.

Keywords: Agricultural innovations, adaptations, fragile ecosystem, State Boundary, periphery

INTRODUCTION

East Nusa Tenggara (ENT) Province, Indonesia in general has specific biophysical characteristics that differ from the western part of Indonesia. The region is dominated by up-lifted coral reef, infertile soils, low and erratic rainfall (Audley-Charles 1965, 1974), making it as fragile ecosystem (Ormeling 1957). These specific characteristics of ENT Province have been less taken into consideration in national development programs at least up to the 1980s.

Despite improvement in terms of food security and income generation of upland farmers, agricultural development programs and better access/transboundary markets have also contributed to the deterioration of some important or specific upland commodities in semi-arid region of East Nusa Tenggara. For example, Timor apple once dominated local market up to 1970s has been infected by *Marsonina* at the end of 1970s and completely destroyed in the 1980s. So'e oranges, well known as JKS or *jeruk keprok So'e*, is recently deteriorated by pests and diseases (Ngongo 2010), and very recently is blood disease of banana in Sumba Island (Mudita and Benu 2018).

East Nusa Tenggara of Indonesian province shares borderline with Republic Democratic Timor Leste (RDTL, East Timor) around 268.8 km long, which includes around 15.2 km long borderlines between Amfoang region of Kupang District and Oecusse District - an enclave area of East Timor (BNPP 2015). Amfoang region is considered the most isolated area in Timor Island due to lack of basic infrastructure. However, in line with central government commitment to develop Indonesia from the periphery, Amfoang regions recently receive some programs to unlock the physical isolation of the region.

One strategy to improve food production and welfare of the people in the state boundary region is by introducing appropriate agricultural innovations. Since 2013, Ministry of Agriculture through East Nusa Tenggara-Assistance Institute for Agricultural Technology (ENT-AIAT) has supported farmers in the boundaries of West Timor (Republic of Indonesia) and Republic Democratic Timor Leste (RDTL) through introducing/improving agricultural innovation in order to increase agricultural production and farmers' income. It is implemented through Agricultural Innovation Field Laboratory (AIFL) and similar program continues up to recently with so-called Agricultural Innovation Support (AIS) in the state boundary of RI-RDTL (Ngongo et al. 2018). This paper overview agricultural innovations in remote areas of state boundary of RI-RDTL particularly in Kupang District, and

investigate the responses and adaptability of farmers' to the harsh environment.

MATERIALS AND METHODS

The study was conducted in the state boundary of Kupang District (East Nusa Tenggara Province, Indonesia) and Oecusse (East Timor/RDTL). Three villages namely: Netemnanu, North Netemnanu and South Netemnanu of East Amfoang Sub-district, Kupang District, East Nusa Tenggara Province, Indonesia (Figure 1) were chosen purposively based on the closeness or in the borderline with Oecusse enclave of East Timor where adaptive research for food crops (rice and maize) from the Agricultural Innovation Support (AIS) Program was conducted. Data and information used were part of the AIS Program. Baseline data and information gathered prior to the Program was started at end of 2016. The data and information were updated and enriched during Adaptive Research/Program conducted from 2017 up to recently. The research employed descriptive method for data interpretation

Some insights of similar programs implemented in three other districts (Belu, Malaka, and Timor Tengah Utara) that share borderlines with East Timor were also used to enrich the narratives.

RESULTS AND DISCUSSION

Overview of agricultural innovations of the region

Almost all upland farmers in state boundary of Amfoang in Kupang District are still practicing traditional farming practices. Shifting cultivation with slash and burn agriculture is practiced by majority of upland farmers with less or no external inputs use. Slash and burn or shifting cultivation has been practiced in Timor Island in general since the 13th century which can be traced to when Chinese traders reached Timor with the main motive to buy sandalwood (Wolters 1967). This means that agricultural practices in the remote areas of Timor remain unchanged up to recently.

Although upland farming practice remains unchanged, local people were able to incorporate some new crops brought by outsiders, particularly by Chinese and Indian traders who buy sandalwood (Schafer 1963). Introducing new crops continued during the Dutch colony, particularly horticultural crops were mostly planted in the highland of Mutis and Amfoang regions to supply local markets in Timor (Ngongo 2011). Upland farming practices and extraction of natural resources in the region are dual economies in subsistence crop production and source of cash income (Chopin et al. 2017; Shepherd and Palmer 2015).

Figure 1. The study site in East Amfoang Sub-district (red box), Kupang District, East Nusa Tenggara Province, Indonesia

Introduction of new crops before and during the Colonial era had positive impact on the improvement of food security of local communities (Ataupah 1992). However, the introduction of livestock particularly cattle brought improvement of local people income but it negatively impacted the environment (Boxer 1949; Ormeling 1957). Until recently, Bali cattle almost replaced water buffalo in Timor. The region of Amfoang and Mutis becomes traditional breeding areas for Bali cattle, causing major problems for crops farming and environment (Figure 2). Free-ranging cattle in the region limited farmers to extend their cultivation area for crops and forced farmers to invest more labor and money for fencing to protect crops. Free-ranging cattle in the protected forest make it hard to do vaccination and to control transmitted diseases.

In the semi-arid region of Timor, water is the main constraint in food and fodders. During the long dry season, cattle are heavily dependent on rice straw in abandoned paddy fields after harvest. Rice paddy field become common grazing area for cattle, limiting the chance to develop dry season crops. One of the main innovations needed for this problem is how to provide fodders of good quality.

Leucaena is the main innovation introduced both to provide good quality fodder and to improve soil quality. This innovation is actually started in Amarasi and then spreads across Timor island and other parts of East Nusa Tenggara Province in general (Piggin and Parera 1984). Nevertheless, Leucaena introduction is less adopted by the farmers in Amfoang region. In contrast to the Amfoang region, farmers in the neighboring area of Timor Tengah Utara (TTU) District have adopted and integrated Leucaena into their farming system. Indeed, most of the TTU landscape recently covered with Leucaena (Figure 3), permitting cattle fattening system works and improving soil quality that shortens fallow periods in shifting cultivation practice.

A **B**

Figure 2. Cattle free grazing in the highland and in the lowland of Amfoang region. A. Free grazing cattle in the highland protected area, B. Free grazing cattle at the abandoned rice field after harvest

A **B**

Figure 3. Innovation through introduction of Leucaena in TTU. A. Landscape covered with Leucaena in TTU District, B. Leucaena in rocky land and being cut for land preparation of upland farming in TTU District

Key informants in East Amfoang informed that the main reason why Leucaena and related fodders innovations do not work in Amfoang region is due to people feeling that there is enough open access area, including in government-protected areas that can be used for free grazing. They also feel that they have enough fertile soils in the coastal areas for crop farming and then become grazing areas during dry season.

Based on the above account, very limited agricultural innovation is being introduced and adopted by farmers in the Amfoang region. Adoption constraints are more on socio-cultural aspects rather than technical aspects. Therefore, institutional and social engineering should go parallel with the technical aspect of bringing improvement in Amfoang.

Overview of induced agricultural innovation in the state boundary

Of the four districts in West Timor that share borderline with East Timor, Kupang District is the last district where agricultural programs for state boundaries are implemented. Belu District is the district that gets first benefit of the program. Related programs to improve food crops productivity started in Belu in 2013, while in Kupang District started in 2017.

Under the AARD&D-Ministry of Agriculture has launched the Field Laboratory of Agricultural Innovation (FLAI) program in 2013/2014. The FLAI program was first implemented in Belu District as part of the AARD&D's commitment to developing state boundary through accelerating agricultural innovation adoption rate. The main goal of FLAI is to increase the roles of agricultural sector in improving people's welfare in state boundaries through agricultural innovation.

The FLAI program was designed to improve productivity of six main commodities, i.e.: rice, maize, mungbean, horticulture, cattle and forage. All activities have been carried out in the concept of CLS and zero waste, and focused on Raihat Sub-district, Belu District. Adaptive research for those commodities was carried out in the flat land along Malibaka river bank. Innovation being implemented to improve farming practices has significant impact to increase productivity for all commodities. Innovation related to lowland rice farming has profound impact to improve rice production and it has triggered the increase in rice planting area and increase in adoption rate of rice planting innovations.

Besides continuing improving agricultural innovations in specific farming circumstances of Indonesia-East Timor, FLAI program in 2016 was focused to improve food crops (rice, maize, and mungbean) production and to improve seed production. By the program, rice seed producers in Raihat were also able to produce seed that was supplied to the neighboring districts of Malaka and TTU and even to neighboring farmers in Maliana District of RDTL (BPTP-NTT 2016).

Agricultural innovation was introduced in state boundary of Kupang District based on the baseline survey conducted at the end of 2017. It was revealed from the baseline survey that productivity for all commodities is considered low and almost no external input or new innovations are implemented in the existing farming systems. In these circumstances, AIAT, in collaboration with farmers and extensionists, agreed to conduct adaptive research for staple crops, first: rice and maize, and then will introduce other innovations related to livestock and income generations.

Adaptive research for maize was conducted in South Netemnanu, while rice was conducted in North Netemnanau village of East Amfoang Sub-district in 2017/2018 rainy season. First-year implementation of the program was a challenge due to limitations in human resources (farmers) and extension workers who have passion for staying in the field due to poor infrastructure. Nevertheless, those farmers who were involved in adaptive research (co-operator farmers) showed excellent performance. Implementation of recommended innovations had significant impact on the improvement of productivity and production of both commodities. Productivity of three high yield varieties (HYVs) introduced namely Inpari 9, Inpari 6, and Ciherang increased double (6.6-7.23 ton/ha) compared with local variety (3.26 ton/ha). The productivity of HYVs is consistent in the last three planting seasons. Similar to rice, there was steady increase of introduced maize (Lamuru) productivity of 4-5 ton/ha compared with the existing local variety of maize (0.8-1.2 ton/ha) (BPTP-NTT 2018).

The above account revealed that farmers in semi-arid areas, at least co-operator farmers in the state boundary, are willing to adopt new innovation if it suits their household circumstances. Marginal farmers in semi-arid areas tend to be vigilant and try to minimize risk for any introduced innovation.

Food security and protection of natural resources: Honeybee case

Food security is still the main priority for households and small farmers in general in state boundaries; however, Timorese dominated by Meto tribe in state boundary of Kupang Districts always feels secure in food production. The term of secure or enough for local people does not mean that food production is enough for households. Rather, they try to manage food production and combine them with access to forest products to meet household' food security.

There are several ways for people in state boundary to ensure household' food security. The most common strategy is by planting many possible food crops in a parcel of land or in several parcels of land at farm level. McCord et al. (2015) stated that: "Crop diversification is one strategy that smallholder farmers may employ to reduce their vulnerability in the face of global environmental change." Farming in semi-arid areas visage high risk of failure mainly due to water limitation. Therefore, planting many possible crops ensures that at least one or two crops will be harvested and can minimize vulnerability.

The upland farming practice fully depends on rainfall and therefore it could be practiced during rainy season (November/December-March). Like other places in upland Timor, main food crops in upland are maize, pumpkin, and

beans, however, the composition of the crops varies based on the zone agro-ecosystem and farmers' experiences on their land. Upland farmers in hillsides of Mutis, for example, plant more roots crops like sweet potatoes and vegetables. No maize is planted in the highland during rainy season due to cool weather and strong wind during monsoon season. Maize planted on limited area in the highland is only during the dry season.

To meet their staple food (maize) needs, people in the highland do have a parcel of land at lower altitude that suits maize. They keep planting root crops and vegetables in the highland both in rainy and dry seasons mainly for cash income (Figure 4). Every household has different sizes of land, species of plants, and business scale.

For Timorese in the state boundary of Amfoang-Kupang District, natural resources, particularly forests, are important parts of food security. Food deficit from upland farming can be compensated from non-timber forest products like Dioscorea sp., and most importantly honey. For local people, protecting forests has positive correlation or direct impact on maintaining the traditional honeybee management. Dominant respondent farmers in the state boundary of Kupang District revealed that main aim of honeybees management is to obtain cash income. Other important motives are conserving norms and local traditions, protecting biodiversity, and ecology functions (Table 1).

Tobe (or elders) who are responsible for the management of honey will make an announcement to the community and set calendar from "calling the honeybee," harvesting up to let "the honeybee return to its first kingdom place." A ritual to call the honeybee to come in the community's forest concession is performed in the arranged stone altar.

According to the respondents in Netemnanau village, best honey quality occurs during Eucalyptus sp flowering, and therefore people are strictly prohibited from cut-off even single branch of Eucalyptus during this trees flowering. People are also strictly prohibited to cut some trees where honeybees normally hang. Those who are violating traditional rules will be punished by paying animals (normally pigs) and rice. Blood from the slaughtering of animals is considered atonement with the "wounded nature" or to calm down the "angry nature" and then reconcile with nature.

Besides protecting Eucalyptus sp. as main source of nectar, elders in Netemnanu village informed that they also strictly protect the trees where the honeycomb normally hangs. They noticed five important trees as *Fanik, Neke, Nisa/Nitas, Niku,* and *Bonak.* Elder Oematan figured out one of the Fanik trees (Figure 5) that he predicted it ages around 250-300 years old based on his grandfather's story.

Besides protecting the forest, local people also protect the honeybees by letting the honeybees reproduce twice before their honey harvest. This strict role is still implemented until recently. They started to harvest the honey when elder oversaw that the honey was mature enough to be harvested. He stated that they normally harvest first of the mature honey in the lowland and then followed with the midland and the last harvested in the highland.

Table 1. Respondents motives in traditional honeybee management (n=45).

Aspect/s	%
Main source of cash income	93
Ecology functions	53
Protecting biodiversity	79
Conserving norms and tradition of honeybee keeping	89

A **B**

Figure 4. Various crops planted in the highland. A. Limited maize and various vegetables planted during the dry season in the highland, B. Various crops in a parcel of land during dry season in highland.

Figure 5. Elders Oematan explains how they protect the Fanik tree (ages 250-300 yo) where the honeybees normally hang every year.

Honey is harvested together by a group of people that have a traditional concession forest area. Those involved in honey harvest should follow traditional procedures and, most importantly, have "clean heart." They make a camp in the forest and stay there to complete the harvest for around two weeks. They are harvesting the honey during the nighttime (07.00 pm-04.00 am) while during the day, they are resting and preparing logistics. Harvested honey will be shared equally with all members of the group.

Elders Oematan in Netemnanau village informed that they do harvest honey twice a year: April-May and September-October. The best quality of honey is harvested during the first harvest season (April/May) where Eucalyptus flowering; while the second harvest occurs during the dry season where limited trees flower. For Elders Oematan, selling honey is main source of cash

income and it helps to compensate for food shortage or crop failure. Crops failure may occur, but no total harvest failure of honey in his forest concession.

Collecting honey in Amfoang and Timor, in general, is considered one of the ancient activities of the local people. Collecting honey has broad impacts not only on the household income but also on the community's environment and social relations (Lyon and Parkins 2013). It is predicted that around 40% of the household involved directly in honey harvesting. According to the elders in Tuamnanu village, they have strict roles in managing the traditional honeybee harvesting business. They are proud that they are able to keep their traditions particularly for hanging honeybees; however, they are quite permissive for cave/underground honeybees.

The position of elders is inherited from his descendants and it cannot be transferred to other members of community. Every elder has its community concession land for generation that can encompass at least one village. The altar where the elder and community members perform ritual for honey bee management in Netemnanu village is part of government forest area; however, local people can freely take the benefit of the forest and at the same time protect the forest.

In conclusion, traditional upland farming system is still practiced in the state boundary of RI-RDTL RIRDTL since fewer agricultural innovations were introduced in the region. The remoteness or isolation of the region limits the farmers to access agricultural innovations and markets. Nevertheless, recent new paradigm in looking at state boundaries by central government as "front porch" has promoted improvement in many aspects of rural development in the region. Lessons from the AIS program in state boundary showed that there has been increase in maize and rice productivity for co-operators and surrounding farmers who implement recommended innovation. Farmers are willing to adopt any agricultural innovations that suit household circumstances and their environments. Farmers are able to harmonize farming activities and protect natural resources, particularly in relation to honeybee management. Dry-forest dominated by Eucalyptus in Amfoang-Mutis has played important roles in semi-arid ecosystems. It is important to ensure that any government programs to open the isolation of the region by improving infrastructure in the state boundary will maintain balance between the will to increase agricultural production and protection of natural resources.

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