

Change of Agricultural Technology and Impacts on Farmer's Relationship with Nature and Environment in Timor, Indonesia.



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ABSTRACT: This paper examines the impacts of agricultural technology changes on farmers' relationship with nature and their environment. Based on a field study in Bena Irrigation Area in South Amanuban Sub-District, Timor, East Nusa Tenggara, Indonesia, this paper analyses how the introduction of new technologies in agriculture by the Government of Indonesia in these last 30 years has changed the farmer's pattern of cultivation, their views about nature and environment, and the ways they link their agricultural activities with social life. This study found that many of the traditional steps in the cultivation cycle have disappeared or been replaced by new technologies, resulting in profound changes in their views and attitude to nature, the environment and social relationships. Impacts on agriculture productivity are still debatable. However, this study argues that some supporting policies are necessary to make the use of new agricultural technologies give the best benefit for the welfare of farmers and the preservation of nature.

KEYWORDS: Sustainable Rural Development, agricultural technologies, cultivation cycle, Green Revolution, nature and environment, preservation.

I. INTRODUCTION

After the economic growth approach, the Sustainable Development approach, including agriculture and rural development, emerged in the 1980s (Chambers, 1983; Reijntjes et al., 1992; Shepherd, 1998). This approach challenges the dominance of the economic growth approach known as the "growth-with-modernisation" (Mitchell, Ingco & Duncan, 1997). The economic growth approach has appeared in the strong Green Revolution strategy and programs in rural development for many years. The Brundtland Report (Rogers et al., 2008: 42) defines sustainable development as "development that can meet the needs of today without compromising the ability of future generations to meet their needs". In the agricultural context, it is an "ecologically sound, economically viable, socially just, humane and adaptable" agriculture (Reijntjes et al., 1992: 2). The three main principles of sustainable agriculture are local potential as the basis of development, the use of local knowledge and wisdom in development, and comprehensive and integrative conservation.

The government of Indonesia has introduced new agricultural technologies in rural development since the 1960s. This is part of a new agricultural development approach, including introducing fertilisers, pesticides, high-yielding variety seeds, agriculture machines, irrigation and new agricultural cultivation. The provincial government of East Nusa Tenggara has also implemented many of these programs since the 1970s. Part of it is the construction of dams and irrigation facilities in many parts of the province, including in the Bena area, the South Amanuban Sub-District. The construction of irrigation in Bena in 2004 (Bena Irrigation Project I) and 2012 (Bena Irrigation Project II), the location of this study, has been followed by the introduction of new agricultural technologies (machines, fertiliser, pesticide, seed) to farmers who previously performed their farming activity using the so-called "traditional technologies".

This paper analyses the impacts of introducing new agricultural technologies in Bena Irrigation Area, South Amanuban Sub-District, Timor, Indonesia. The question this paper seeks to answer is how the introduction of these new technologies in the current pattern of cultivation has changed farmers' views about nature and the environment and how they link their agricultural activities with social life.

II. METHODS OF RESEARCH

This study follows a qualitative approach, especially the case study method. Data were collected through participatory observation, in-depth interviews and document study. Topics and issues of interviews were selected through a coding process in two steps. Step one is general and random issue selection, and step two is the selection of issues based on three areas: changes in cultivation patterns, changes of views about nature and environment, and changes in social life views.

III. LITERATURE REVIEW

Up to the 1980-s, development perspectives and strategies have been dominated by economic growth approaches (Mitchell, Ingco & Duncan, 1997). This approach's agendas or recipes spread massively throughout Asia, Africa and South America. Those are agriculture extensification in order to provide supply for business and industry, supported by bank credits, focus on household economy development for consumption raise, business knowledge and skill for farmers, the establishment of farmers' organisations, youth clubs for preparing future farmers, and basic education (Shepherd, 1998; Johnston & Mellor, 1961; Mellor, 1966; Lee & Goodland, 1986). Along with the economic growth approach, the Green Revolution strategy has gained its central place in rural development programs since the 1960s. Agricultural programs, funded by Rockefeller Foundation, Ford Foundation and the US Government, intensively promoted new agricultural technologies that have never existed before. Green Revolution comprises strategies for the modernisation of agricultural systems and cultivation in developing countries of Asia and South America. New fertilisers, pesticides, high-yielding variety seeds, modern machines and new cultivation patterns were introduced to the farmers. The creator of the Green Revolution concept, Norman Ernest Borlaug (1968), was granted Nobel Prize in 1970 for his significant contribution to food production increase and poverty reduction.

According to Shepherd (1998: 25), initially, the Green Revolution concept referred only to the agriculture package, which included fertilisers, agrochemical products, and soil moisture arrangement. Later the notion has been widened to include the increase of market surplus and purchase of agricultural inputs, which have inserted farmers more deeply into the market system (See also Pearse, 1980: 158). Furthermore, Green Revolution also includes using modern technologies in agriculture and high public spending in agriculture to support agricultural growth through commercialisation and industrialisation.

The theoretical framework of the Green Revolution strategy can be seen clearly in several conditions for agriculture development, as defined by Mosher (1966, 1985). There are five basic conditions: the market for agriculture products, new technologies, provision of raw materials and tools for production at the local level, production incentives and transportation. Farmers need accessible and reliable market access to sell their products at the highest price and provide income security. New technologies are necessary for more efficient and productive land cultivation. They include machines (tractors, ploughing machines, rice threshing machines, harvesting machines, rice mills), high-quality seeds, fertilisers, and irrigation technology. National governments are given recommendations to provide enough machines and tools for farmers to increase their productivity. Incentives are also important to stimulate the improvement of production. The possible forms of incentives are financial capital subsidies (soft loans, grants), provision of high-quality seed, fertiliser and pesticides, government guarantees in market prices, marketing facilities, and so on. Furthermore, finally, a decent transportation system is needed for the distribution and marketing of agricultural products. It should be practical, low-cost, secure and easily accessed. Additionally, there are supporting conditions such as farmers' education and training, farmers' organisations, land expansion and irrigation, and proper agriculture planning.

Green Revolution proponents claimed that Green Revolution had brought positive impacts like increased farmers' welfare, rural economies have become stronger, better national food security, and rural communities more open to technology adaptation. However, these claims have little proof in rural communities in Asia, South America and Africa. After three decades of economic growth approaches, the welfare of rural communities has not changed much (Griffin & Khan, 1978; Streeten, 1984; Chambers, 1995). On the contrary, this approach has raised many problems in development and the environment. There is no sustainable impact of economy-based policies on the livelihoods of the rural poor and their environment (Agarwal & Narain, 1985).

Shepherd (1998) describes two main weaknesses of the Green Revolution approach. The first relates to gaps between areas and groups in implementing and accessing new technologies. Rural areas in Asia and South America have performed more successfully than the ones in Africa (p. 26). There is also a wide gap between rich/successful farmers and small/poor farmers. Wealthy farmers are able to implement new technologies quickly, own large amounts of land and financial capital, and have a more robust and broader market network. Although small farmers have enough skill, they often lack access to water supply, land, a good variety of seeds, capital and network. Pearse (1977) asserts, in more equal rural communities like Java Island, the implementation of high technologies has been more widespread and equal. While in Timor island, East Nusa Tenggara, for example, where a small number of wealthy farmers with firm financial and social capital control the rural economy, the implementation of new technologies is less successful. Another gap is a decrease in employment opportunities and income of farmers. Lipton & Longhurst (1989: 104106) explains that population growth, inequality in development between areas, and rural people's migrating to urban areas for employment search have left rural areas with an oversupply of labour. This is not followed by increased land for agriculture and employment opportunities.

The second weakness is related to impacts on health and the environment. Green Revolution may have increased agricultural productivity but with an expense to be paid by the people for their health and the security of their environment (Conway & Pretty, 1991). High consumption of chemical products and poor management of usage and storage of chemicals have created unprecedented impacts on human health. Bull (1982) found shocking data that there are about 10,000 deaths per year related to pesticide poisoning. Green Revolution programs have also brought severe damage to the environment. Decrease of soil humus, soil, water and air pollution, deforestation, increase of soil acidity, disturbance in ecosystem balance and high loss of biodiversity are

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some examples of the damage. The use of high-yield variety seeds has also removed thousands of local varieties of three primary food sources: rice, maize and corn. The instant use of new varieties in irrigated rice fields caused low resilience of seeds against pests and diseases. Nitrogen-based fertilisers have destroyed "micro-fauna" in the soil, the ones that preserve the soil's health for healthy plants.

Sustainable Rural Development emerged as a challenge and a correction to Green Revolution approach (Shepherd, 1998). Sustainable development is a development that can meet the needs of today without compromising the ability of future generations to meet their needs. This definition contains two critical concepts. First, the concept of needs emphasises that the world must prioritise the needs of the poor. Second, the concept of limitations reminds the world to use the resources available in the natural environment with responsible technology and social organisation. The goal is that the results of development are enjoyed by those who are less fortunate today and future generations at the same time. Sustainable agriculture is agriculture that is ecologically sound, economically viable, socially just, humane and adaptable (Reijntjes et al., 1992: 2). Three principles of sustainable agriculture are the use of local and natural potential while reducing external input, respect for local knowledge and governance; and comprehensive and integrative conservation. Sustainable Agriculture Development underlines the strong linkage between economic development, quality of the environment and social justice, which is called the triple bottom line for sustainable development (Rogers et al., 1997). Sustainable Agriculture Development requires institutional support through government policies and international cooperation to promote sustainable development in Asian, South American and African rural communities.

The Den Bosch Agenda for Action on Sustainable Agriculture and Rural Development (FAO, 1991) defines some critical aspects of agriculture development and rural development which need to be placed at the heart of the development agenda:

- (1) Coherent national policies concern all vital aspects of agriculture, such as subsidy and taxation, regulation/law and incentives, technology, international trends in trade, and demography trends.
- (2) Development of institutional and individual capacity of rural communities (capacity to organise themselves and improvement in decision-making authority).
- (3) Development of environment-friendly technologies (green manuring, crop rotation, integrated pest management and integrated plant nutrition).
- (4) Infrastructure development, not only physical but also capital and post-production facilities.
- (5) Conservation and wise/care use of nature.

Some studies have been conducted to analyse rural community underdevelopment on the island of Timor (Kameo, 2003, 2013; Bele, 2011; Jocom, 2016; Ratumakin, 2016; Neonbasu, 2016; Tjoe, 2017). The findings of those studies show that human and social assets need to be utilised more to maximise the impact of rich natural assets and the introduction of new technologies in agriculture. These studies indicate the rise of attention and acceptance of sustainable development approaches in rural development in East Nusa Tenggara. These studies, however, have had little influence on the decision-making of rural development programs in recent decades. This field study found that "Green Revolution" type programs are still dominant. Sustainable rural development programs are good on paper but face great challenges in practice. There is still a long way to go. This study argues that many efforts are still needed urgently to make sustainable agriculture the primary approach in rural development at a conceptual and practical level.

IV. RESULTS AND DISCUSSION

A. Change of Views about Nature and the Environment

The majority of farmers in Bena are Atoni people (Schulte, 1971; McWilliam, 2002). They are traditionally dryland farmers. Farming was commonly performed in the highlands, while lowland Bena was an area for livestock raising and hunting. There is no clear information about when exactly people moved from the highlands to lowland Bena and started rice cultivation. Most probably, farming activity in Bena began in the 1950s when the Rotenese began opening rice fields. Water supply for rice fields relied on rainfall and was derived from a small river called the River Panite. Along with developing irrigation facilities in Linamnutu village and expanding rice field construction, potential land for cultivation multiplied significantly to 17,000 hectares. Around 3,500 hectares of it have gained access to water supply from the irrigation facility. The number of farmers has increased since then, especially in three villages that enjoy water supply from irrigation, i.e. Linamnutu, Polo, and Bena.

Since the 1970s, the government of Indonesia has significantly invested in agriculture and introduced new agricultural technologies extensively, including in rural Timor. The new technologies include the preparation and cultivation of rice fields, use of machines, selection of high-yield variety seeds, provision of fertiliser and pest control, and irrigation system. The introduction of these technologies is supported by technical accompaniment, post-harvest facilities/mechanisms (transportation network, market), and microfinance loans.

How have these new technologies changed the traditional agriculture cycle of Atoni farmers? Schulte (1971) contends that dryland agriculture is the primary economy of the Atoni people, and the main product is rice and corn. The agriculture cycle is long and full of religious, social and ecological values, as Schulte (1971: 52) states:

Agriculture is of much greater economic importance than either animal husbandry or trade. Moreover, the agricultural cycle

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determines the rhythm of Atoni's entire life and is the basis for the political system. The agriculture ritual's climax and culminating point is the presentation of the harvest gifts to the sacral ruler, so the knowledge of this ritual is important for understanding the political system. The chief food crops are corn and rice, cultivated in rotation. Rice is the most valued and is planted on the most fertile land, especially on forest land, the first two years after it has been brought under cultivation. This is sometimes suitable only for corn in the second but usually in the third year. The garden is generally abandoned after the third or fourth year. In the drier areas, millet is also grown.

The traditional agriculture cycle of the Atoni people (Schulte, 1971: 53-89; see also Foni, 2003) comprises 14 activities of land preparation, maintenance of plants, harvesting and post-harvesting activities. It provides rich information about their cosmic balance, which comprises religiosity, kinship relations, land tenure, relation with the environment, political system, gender relation, social unity, agriculture tools, and cultivation skill. Schulte (ibid. 89-91) makes some concluding points about this cycle. Firstly, Atoni's traditional agriculture cycle connects strongly with religious/sacral rituals. In most of the activities in the cycle, farmers performed worship and presented sacrifices to the Lord of Heaven (Uisneno) and Lord of Earth (Uispah). However, only the planting cycle of rice and corn use has this ritual. This fact indicates the primary of rice and corn among other agricultural plants. Secondly, there is a strict division of work between males and females, which also defines their different position in cosmic balance. Thirdly, when rice and corn are in the planting cycle, they are not called by their daily names (ane and Pena). In the sacral context, cosmic symbolic names replaced daily names.

The introduction of new technologies has resulted in several changes in the agriculture cycle. Firstly, the cycle has become shorter in terms of time/period of cultivation. The traditional cycle used to take several weeks for land preparation. It included choosing a plot of land, cutting down the trees, burning off, preparing tools, extinguishing the bamboo as a ritual to make soil cool again after the burning off activity, and "cleaning" the seeds to make them pure and fertile. All these preparatory activities were accompanied by rituals at the beginning and end, including having a meal together. In the current rice cultivation process, due to the use of machines (tractors), the preparation of land, especially the small ones, can long only one to two days. No special rituals are involved. During the maintenance period, the traditional cycle involved the making of a fence in preventing animals from entering the plot and constant watch to keep birds and monkeys out. In the current maintenance activities, usually, there is no need to build fences, and machines can help with the additional work of weeding the grass. The traditional harvest period was long since it included different stages of harvesting the first corn, rice and (mature) corn. The process symbolises people's view of young and mature lives, about abundance and shortage of life. The harvest activity in the current cultivation is much shorter since there are no more different stages of harvest, and some activities can be done by machines (harvesting machine, threshing machine, rice mill). Indeed, this shorter cultivation process can make it more efficient in terms of labour and financial capital. However, it may be suitable for the short term but not for the long term or sustainable agriculture. The shorter process has taken out some important parts of agriculture in connection to nature and the environment. As acknowledged by some farmers in interviews, using machines tends to encourage them to become less careful with the soil, and it has caused long-term damage. The use of machines should be accompanied by manual work at a certain level/point. For example, one of the successful farmers in an interview stated that a distinct soil surface and the water level are vital for paddy plants' health. Therefore, manual work is necessary after the machine to make the soil surface level equal. The same manual work is necessary for the threshing process, fertiliser use, and pest control. He acknowledged spending more time in rice fields than other farmers because "paddy plants need attention and care like us humans" to grow healthy.

Secondly, there is a change in cosmic balance. Traditionally, the Atoni people view nature and the environment as integral parts of their lives (Ataupah, 2020). Life is about keeping a balance between the Lord of Heaven and the Lord of the Earth (vertical) and between themselves and other humans. Respect to the Lord of Heaven, the Lord of the Earth, and others will maintain the balance of life to be able to move forward. For example, the "Sifo nopo" (extinguishing the bamboo) ritual is the solemn rite performed to restore balance in the interplay of cosmic forces. The earth has to be made cool again (after the burning off process), and the forces of heat and fire are rendered harmless, while the Lord of Heaven has to be implored to grant fertility for the next harvest. At the same time, the Lord of the Earth has to be given an altar in the garden plot.

New technologies change the cosmic balance. Technology has replaced the role of the Lord of Earth. Nature (soil, water, plants, fauna, microfauna, biodiversity) belongs to the Lord of the Earth. Tree cutting and burning off activities in the traditional cycle made a selection of plants: which ones are to be cut down and burnt, and which ones are left alive. Machines destroy the soil and all plants to clear land for the next. Nature has the capacity to give fertility to the lives of plants. The use of fertilisers indicates that humans have destroyed this capacity and obliged soil/nature to provide lives out of its capacity. Rehabilitation of soil is better than the use of fertiliser. Pesticides destroy micro-fauna; part of them is necessary for the life of plants. Overall, with the massive use of agriculture and modern technologies, farmers have downgraded their Lord of the Earth to become the only means of production.

To restore respect to nature and the environment as the Lord of the Earth, this paper argues, is an urgent part of sustainable agriculture development concepts, practices, and policies at all levels and mass movements. The pastor of GMIT Church of Timor

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in Bena shared that he has conducted pilot projects in organic farming and successfully resulted in high productivity. His church members appreciate them and buy his products but are reluctant to follow the examples since they are time-consuming and need more work. A Claretian brother, who was in charge of the Claretian Congregation rice plantation in Linamnutu and Bena, shared that they ceased to use organic fertilisers since the surrounding farmers still use chemical fertilisers and fly with water into their rice fields. Unless all rice fields in the area use organic fertiliser, then the practice can persist.

B. Change of Social Relationships

The introduction of new technologies has changed social relationships in Bena. Traditionally, the basis for social organisation and kinship among the Atoni people of Timor is *ume* (household) (Schulte, 1971). Some *ume* form *kanaf* (= clan) consisting of all who (claim) to be descended from a common ancestor and therefore use the same (last) name (e.g., Nabuasa, Asbanu, Nope, Banunaek). They also live or have the same *kuan* (=kampung/hamlet), the "sacred stone or sacral source" of their *kanaf*. In the context of Amanuban, a number of *ume* can form a unit and then establish a *loop* (house of origin/custom). Several loops can form one *kuan* (village). In the process of reorganising village government in modern Indonesia, the concept of *Kuan* was then transformed into government units such as hamlets, villages and sub-districts.

The government of Indonesia introduced an organisation system for peasants around the irrigation area in Bena. The first organisation is the peasants' group or union (*Kelompok Tani*). Several groups form *Gabungan Kelompok Tani* (unions umbrella organisation). The main aim is to channel government supports such as machines, tools and loans and to organise training and field technical accompaniment. The membership of these groups is based mainly on kinship or friendship affinities. The second organisation is related to water distribution and management. It is called the Union of Water Supply User Peasants (*Perkumpulan Petani Pemakai Air - P3A*). The membership is based on the location of irrigation gates. Any decision about water management and distribution is made through a democratic agreement process in these unions. However, several resource persons informed that the ones with power have often determined or pushed the decisions in their favour.

Family and community are the mainstay and support for the people in Bena. The interviewees informed that the majority of the workforce in their rice fields was kinship-based. However, it is also recognised that this kinship-based mutual aid system has begun to fade and be replaced by a wage system. The costs for social relations and activities have been relatively high. However, the majority of Bena people view social costs as beneficial investments, and they understand that social costs are reciprocal. To be able to share welfare through parties and family gatherings, and celebrations is pride and show prestige.

Compared to the traditional cycle, the current agriculture cycle in rice field cultivation slowly removed community-based social relationships into more kinship-based and even household-based ones. Furthermore, others in the cosmic balance have become human power tools of production. The rising number of paid workers and the basis for Farmer Union memberships indicate the decrease of community centrality in social relationships. Unlike traditional social activities, mostly connected to agriculture and became part of sacral rituals, current common social activities have been chased out mainly from the agricultural cycle and replaced by church and government calendars. There is only one community gathering at the end of the harvest period (once a year). The position of other community members outside the household and kinship circle in the cosmic balance have become tools for production, just like technologies. This paper argues that restoring and strengthening community-based social relationships in the current agricultural cycle is urgent and important because some vital issues need to be taken care of by strong decisions and commitment at the community level. Those issues, like water distribution and management, the common practice of organic farming, paddy protection from animal/livestock, care for the environment, access to subsidies, public facilities and training, very often become the source of conflicts if not handled carefully.

CONCLUSIONS

The introduction of new agricultural technologies has resulted in changes in farmers' views on their relationship with nature, the environment and others. In the new cosmic balance, technology has replaced the role of the Lord of the Earth as the owner of nature and has downgraded nature's richness as production tools only. The decreased respect and care for nature has created long-term damage to nature's capacity to provide life for plants, animals and humans. To restore respect to nature and the environment as the Lord of the Earth is urgently needed to become an important part of sustainable agriculture development concepts, practices, and policies at all levels and mass movements. The current agriculture practice in rice field cultivation has slowly removed communitybased social relationships into more kinship-based and even household-based ones. It has placed the others in the cosmic balance as production tools. Common efforts are needed to restore and strengthen community-based social relationships to face important issues such as water distribution and management, the common practice of organic farming, paddy protection from animal/livestock, care for the environment, access to subsidies, public facilities and training.

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