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Agricultural Local Knowledge System: Lesson Learn from Rural Development In Mekarjaya Village, Kabupaten Purwakarta

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Abstract. Local knowledge termed traditional knowledge contributes to the quality of human life improvement in rural area. As the local knowledge which held by Mekar Jaya villagers, traditional agricuture practices emphasizes continuity and long-term practices. This article discussed about how local knowledge contribute to rural development as a whole of agricultural system. How external modern technology meets the accumulated traditional knowledge are elaborated in a social-ecological system using system archetype. The value of traditional agriculture practices have shifted gradually from food security purpose to food commercialization in line with the modernization technology. Social element in local agriculture practices looks more respect to environment than modern agriculture practices, while social element in modern agriculture tend much more to economic aspect. Finally, personal curiosity and willingness to learn, together with social networking among farmers and community, and supportive formal knowledge and governance structures, are learning point for successful sustainable agriculture development

1. Introduction

Traditional ecological knowledge represent accumulated experience in a long period of direct human contact with their environment. Local people developed their practice of resource use on their perspective based on experience and knowledge. Shortly, traditional knowledge is a complex interaction knowledge-practice-belief [1]. The result of many Traditional Ecological Knowledge systems shows that there are many components built the system: a) local observational knowledge of species and environmental phenomena, b) practice in the way people use their resources in activities, c) belief about how people fit into relationship to their ecosystem.

Traditional knowledge can be describe as informal knowledge because it is not a modern research product. Traditional and local knowledge systems are dynamic expressions in perceiving and understanding the world [2]. Traditional knowledge in the type of informal knowledge can be as local context, practice-based, traditional and indigenous and endogenous with self-education, learning by doing and social interaction. Informal farmers knowledge come from their experimentations and practical experiences on the farm, holistic approach, own by local community and locally specific solutions [3].

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Traditional knowledge or informal knowledge as a holistic approach in agriculture practices and concern with the ecosystem in many cases, have strong relationship between peoples and the environment. Traditional ecological knowledge is the term used to describe the knowledge and beliefs that local peoples hold of their environments that is handed down through the generations include indigenous peoples. With or without ecological knowledge, traditional knowledge or informal knowledge should have a good correlation to environment and human. Traditional knowledge is adaptive by nature and holistic in outlook, practically it accumulates incrementally, tested by trial-and-error and transmitted to future generations orally or by shared practical experiences directly [4-6].

Since Green Revolution replicated in Asia, farmers in Indonesia have become dependent on synthetic fertilizers and agricultural chemicals input such as pesticide to sustain the food productivity. Farmer independency have been decrease slightly in the last four decades during the introduction and implementation of modern knowledge which came from the outside of rural area. Relation between human and technology as socio-technique relationship in the farmer society growing faster and effective as economy accelerator in the 80's until 90's era. At the other side, foreign pesticide companies have benefitted as the demand for high imported pesticide product has ben increased [7].

This paper analyse the agricultural local knowledge on farmer communities through a study of rural agricultural system in Mekarjaya village, Sub Dictrict of Kiarapedes, District of Purwakarta, West Java. Our analysis focus on the adaptation mechanism of traditional knowledge facing modern knowledge in agriculture activity, mainly rice or paddy as food and also discuss changes in economic income in rural development.

2. Material and Methodology

Ecological agriculture is a complex system involving ecology, economics, industry, human behavior, policy and society. Each element interrelated one to another built an agricultural rice system include human-ecosystem relationship. Recognizing these complexities, we do an interdisciplinary approach in data collection and analysis, combining with community-based ethnographic studies.

Focusing on adaptation mechanism of traditional knowledge facing modern knowledge in agriculture activity, we chose rural community who applied traditional knowledge in agriculture practices of Mekarjaya village Sub Dictrict of Kiarapedes, District of Purwakarta, West Java. Most of people who live there are wetland paddy farmers in the medium land about 500 meters above sea level. Mekarjaya village is one of the village in Purwakarta district where the traditional culture still upheld by their peoples. Nowadays, no one of the farmers in Mekarjaya applied the traditional knowledge in paddy farming completely except chief of traditional village. All the farmers have adapted modern technology since 1977 after a terrible pest disaster one year before.

The first stage of data collection involved the use of three key informants who were local experts and praticioners in paddy farming, they have adapted from traditional to modern technology. Another key informants are government in extension services and head of farmer group association in Mekarjaya.

The next stage was 15 farmers of the communities who were chosen purposively by the key informant, involved into a focus group interviews during September to October 2017. Comprehensive information to answer the research question in qualitative research sampling is the main consideration, because of the external validity of case studies is based on the logic of replication rather than on sampling logic. Individually, this study also identify technology used in farming by surveying farmer experience of farmer group members that divided into two group of modern or traditional technology.

After conducted several number of interviews, all data (mental and written database) on traditional knowledge and its adaptation were analysed. We looked for patterns, definition, stories and lessons related to the topic from all informants [8]. The data was analysed with system thinking approach. Complexities and interdependencies in knowledge management were then drawn clearly in a causal system diagram, it is powerful to sort the problem. Traditional knowledge as an object accumulating over time is a massive and complex interdependent system. Traditional knowledge is a cyclic learning process on how to learn continuously and effectively and how to manage knowledge of people in a

favourable environment. Traditional knowledge helpful to guide an effective decisions, cultivate trust and mapping the relationship of knowledge flow and information within the organization and its environment [9,10].

Validation is confidence building of the research model [11], we used a triangulation method to collect information from different person or informant, then compared to the existing theory and the relationship of causality as information control. Feedback loops in system thinking are research control to identify logic causality of empiric evidence. Charting feedback loop in this article created by Vensim DSS Software to obtain the cause of the feedback and the leverage point that occurs in the model structured.

3. Result and Discussion

Based on field research, traditional knowledge application in paddy farming in Mekarjaya is characterized the variety of cultivated paddy by farmers. The vilagers known this practice with the term "buhun" (Sundanese : old or traditional). The old cultivated paddy was a long term growing variety (between 5-6 months), so that only cultivate once a year. Nowadays, farmers cultivate paddy's "buhun" very rarely because of long term growing, these has begun since 1977 and become the change milestone of traditional farming practices. Great pest attack to their local paddy plantation forced farmer to switch their paddy to the short term growing and pest resistant variety. Since the disaster many modern technologies arrived to Mekarjaya and adopted progressively in crop agriculture system, such as synthetical fertilizer and chemical pesticides until now.

Food Commercialization and Food Security

Rice (*Oryza sativa* L.) is the main food of Mekarjaya villagers. Before 1977, people cultivated paddy only for food availability reason. They stocked up paddy as dry grains, then processed them to rice for daily consumption. Most of cultivated wetland in Mekarjaya are forest area managed by Indonesian Forest Enterprises (Perhutani). The forest conversion to agriculture land are allowed through annual rent payment once a year.

According to information from chief of farmers group association, deforestation in Mekarjaya have been started since before of modern agriculture technology was officially introduced, the speed run slowly at that moment. However, agriculture land availability in the 1970-an era were insufficient to meet food requirement of Mekarjaya people, therefore forest conversion for agriculture land was unnecessary.

The situation changed since modern technology applied in Mekarjaya, the practices of modern agriculture through numerous components manufactured externally to the farm (fertilizers, pesticides, and technology) manipulates the land to make it amenable to industrial processes [12]. Socially, the value of agriculture was shifted gradually from food security purpose to food commercialization. The use of short growing period paddy variety resulted in a more frequence paddy cultivation (2-3 times a year) that lead to a higher yield and increase accumulated excess production of paddy grains. Farmer household have much more rice stock in their storage so they can sale their rice beside for own consumption in order to increase household income. Today, paddy is a commercial plant commodity for farmers as a result of surplus grains from their household consumption. These has changed people's value to paddy, they not only respect to paddy as food fulfilment but also as commercial goods, even worse the next generation people only know paddy as commercial goods as farmers statement in a small focused group discussion.

These changing behaviour to the commercialization agriculture forced more deforestation converted to wider agriculture land production. Farmers have become more aggressive converting the forest area to production field for their better income through agriculture (**Figure 1**).

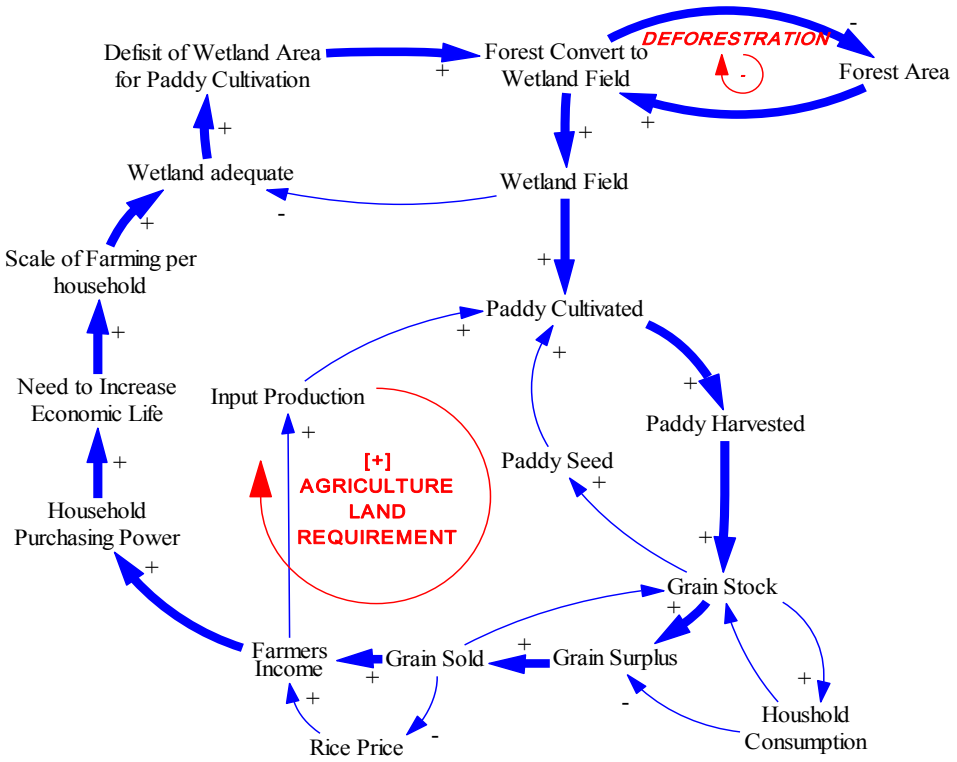


Figure 1. Causal Diagram of Deforestation for Agriculture Land in Mekarjaya

Integration Traditional Knowledge Practices and Modern Practices

Traditional knowledge practices and modern practices are two different systems viewed from its origin and approach. Traditional knowledge originated from experienced local peoples through many practices while modern practices come from research and scientific studies. Traditional or informal knowledge and modern or formal knowledge competition can lead to conflict with each other. Informal knowledge influences in the grass root level while formal knowledge have a strong network in the researcher and policy maker. Informal knowledge operates in a fuzzier networks, relying on community or group ties, community and personal relations, neighbourhood associations, peer groups, and territorial communication structures and traditions. These networks are more local, but not exclusively mainly for community. Knowledge integration and dissemination between traditional and modern practices often occurs through farmers networking both in formal organisations and in informal structures [3,13].

The growth period is an important phase in paddy farming system. Interrelated of social and ecological aspect in traditional practices shows the principles of relationships between humans and their environment. It derived from the principles of relationships among humans, consist of the core moral and ethical values: honesty, fairness, responsibility, compassion, and respect [13]. There are at least two values including in traditional practices during paddy cultivation in Mekarjaya: responsibility and respect. Pest management is an activity which responsibility and respect value were applied in traditional knowledge practices wisely. These practices did not kill pest during paddy's growth period alternatively farmer drove away the pest to move out from their paddy plantation or shifted insect food to another media such as little crab carcass which was clapped using bamboo and put it in the middle of paddy's area. Traditional practices show us how local knowledge respect and responsible one to another, between human with their ecosystem.

Pest control and cropping pattern management in traditional practices considered pest life cycle. For example, food shifting of *lembing batu* insect or *Scotinophara coarctata* into residual straw was

done in the post harvest time. Paddy's residual straws were left growing for the next 3-5 months until reach generative phase. The grain from residual straw become insect's food around September until November every year, so that it will not attack the paddy plantation in the next cultivation session. These methods need collective action to cultivate paddy at the same time. Traditional practices forbade farmer to cultivate paddy before November because of that period is the time for lembing batu insect sought their food in a large population. Entering rainy season in December, traditional practices farmer will started to plowing their land with residual straw inside it using *wuluku* (traditional plowing tool) pulled by a buffalo.

Controlling *Walang Sangit* (*Leptocorisa acuta*) or in local term *kungkang* is another example of respecting pest life found in traditional practices It attacked in April-May every year or in pregnant phase of their paddy. Farmer used fumigation technique to move out *Walang Sangit* from plant then burned out fragrant leafage together in the land during the pregnant phase. Based on these, farmer respect to another organism as they do to human and be responsible not to kill another organism even though it is harmful. Farmer who applied traditional practices said that they responsible and be civilized to their ecosystem and human ethical. Those have become main principle for them because it will preserve food chain in wetland ecosystem (natural pest management and damage of food chain in **Figure 2**).

The powers of social capital of farmer society ease collective decision in pest management such as fumigation and cropping pattern. Social capital network form togetherness in ritual thanksgiving and traditional practices in cultivation have influenced their collective action in pest management and cropping pattern. Every year before 1977, Mekarjaya villagers periodically held thanksgiving ritual after finished their planting and harvest. These reinforce social capital among the villagers, both farmers and another community in the village. Systematically its process described as the power of social capital in pest management (**Figure 2**).

Any research institutions have tried to introduce ecological agriculture practices such as organic farming system at least for two years pilot project. Even though its impact improves their rice production almost two times higher than synthetic fertilizer and chemical pesticide application, but these practices discontinued. Lack of collective actions among the young farmers generate the benefeciary of organic programme stopped their experiment and decided to use synthetic fertilizer and chemical pesticide as others farmer. The organic beneficiary said that organic system requires a big effort in resources management and social collective to ensure the availability of natural input especially fertilizer and pesticide.

Another local knowledge in traditional practices is about frequency of paddy cultivation in the same land. Local paddy variety with 6 months cultivation period was planted almost only once a year. Naturally, the land have 3 months for recovery until next season of cultivation. Today with the short term growing and pest resistant variety (IR series, Ciherang, Mekonga), there are no recovery time for the land because of more frequent cultivation (2-3 times)in one year. Intensive cultivation tends to degrade soil quality in a variety of ways, so that land depletion cannot be avoided in industrial and commercialization agriculture. Application of synthetic fertilizer and intensive cultivation on annual crops dramatically reduce the ability of soils to sequester and store carbon because overuse chemicals use reduce the soil's biological activity and expose its organic matter to depletion by erosion, chemical degradation, and bacterial respiration. In addition, the mineral components of synthetic fertilizers are easily leached out of the soil. In wetland irrigated systems, the leaching problem may be particularly acute because of a large amount of the fertilizer applied to fields actually ends up in streams, lakes, and rivers [14].

Based on farmer experiences, April-May is the time for kungkang pest (Leptocorisa acuta) and every September-November for Lembing Batu (Scotinophara coarctata) to attack their paddy crop. Since cropping pattern has become uninterrupted because of intensive cultivation, chemical pesticide and synthetical fertilizer become an effective choice to secure the food production.

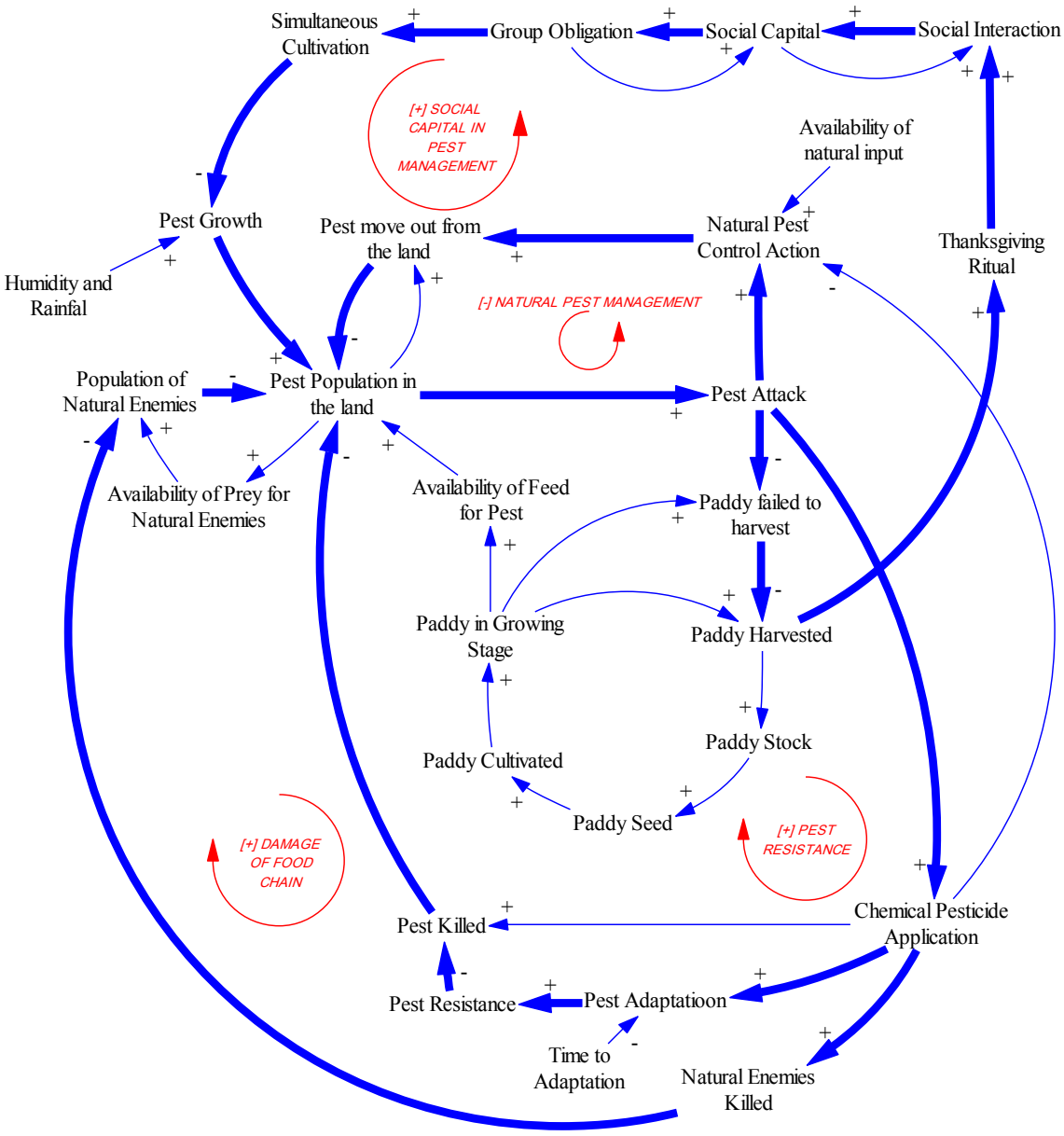


Figure 2. Causal Loop Diagram of Local and Modern Agriculture Practices Integration in Fertilization and Pest Control Activity

Nowadays, natural pest management has been abandoned because of resources allocation and duration for its process turned out not as simple and fast as chemical input. Farmer prefers to use chemical pesticide for pest and weed control because they can dramatically lower pest populations in the short term and at the same time increase pest resistance gradually. When pest resistance to pesticide is happening, farmers are forced to apply larger amounts of pesticide or using another pesticides, that might actually accelerate even greater pest resistance [14]. Actually, farmer realize about chemical application will kill pests' natural enemies, but they do not realize about its impact which is pest populations can often quickly rebound and reach a greater numbers than before as Gliessman [14] explained in agroecology concept . This situation can be captured from their confusion

in pest control especially for insect population which has doubled than a few years ago and attacked randomly during the cultivation (**Figure 2**). Increasing pesticide application dosage has become their choice to solve the pest attack usually. Shortly it is effective to kill the pest using chemical pesticide, but in long period it make another problem environmentally (water pollution) and also greater numbers of insect population and randomly attack.

Trajectory of integration between traditional practices and modern practices in Mekarjaya during 1977 until now has been very dynamic. Technically all of modern technology can be adopted as long as economically profitable and efficient, meanwhile traditional knowledge practices are still maintained about social ritual related to paddy farming system. Eventhough social ritual still exist among the villagers, slowly it has been depreciating since modern technology came to Mekarjaya. Modern technology with less labors utility decrease social connection among the farmers, they have changed from collective farmer to individual farmer. Farmer relationship today is more distant than in the past, as relationships grow in trust, now they have grown weaker because trust in social capital has been depleted. Unfortunately, when the social capital is lost, farmer relationships are no longer sustainable [13].

Socio-Ecological Interaction in Agriculture Practices

Ecology is the science of relationships between living organisms and their environment, on the other hand social system is everything about people, their population, psychology and social organization shaping their behaviour. Human ecology is about analyses the consequences of human activities as a chain effects through the ecosystem and human social system [15].

Point of contact both traditional knowledge practices and modern technology in this case is about relationship among social sciences and natural sciences. It was social–ecological systems that bridging social and natural science. The complexity of social and environmental changes trigger to understand the relationship between social and ecological processes. Agriculture as social, natural and technological system is a complex issue that are interrelated each other. People as a social networking have social institution containing social capital that conceptually and empirically are influenced by economic, technology and environment components [16-18]. Interaction about social and ecological aspect on this paper is drawn in causal loop diagram structure (**Figure 1**, **Figure 2**). We grouped the elements whether to include them in sociological element or ecological elements for comparison between traditional knowledge practices and modern practices **Table 2**).

Social element in local agriculture practices looks more respect to environment than that of modern agriculture practices, while social element in modern agriculture tend much more to economic aspect. Local agriculture practices in the social element are in line with ecological principles of agroecology: holism, diversity, and interdependence [13]. Interdependent relationships in agriculture system are necessary to transform the potential of holism and diversity into positive ecological reality, in this case to avoid failure in paddy harvesting, farmer used natural pest control such as fumigation or shifting pest feed to another media around paddy crop. These methods do not kill natural enemies or another microorganism that may lead to disturb the food chain in wetland ecosystem. In the other hand when farmer used modern agriculture practices, pesticide application kill almost microorganism in the ecosystem include pests' natural enemies.

Sustainable development can be achieved in practice most importantly with preserving the ecosystem, secondly to do things nature. Sustainable development operationally can be reached through social institution to protect common property resources from tragedy of the commons as impact of unsustainable human-ecosystem interaction. Enviromentally, we have to preserve the ecosystem such an extent to provide essential services and carefully to avoid negative impacts for environmental or social when using new technologies. Agriculture as economy sector need to be sustain for the next generation and as a whole-systems approach to production, sustainable agriculture have to balances environmental soundness, social equity, and economic viability [14,15].

Table 1. Social and Ecological Elements in Local and Modern Agriculture Practices in Mekarjaya Villages

Comparison	Social Elements	Ecological Elements
Local Agriculture Practices	- Paddy harvested, - Paddy stock, - Natural pest control action, - Thanksgiving ceremony, - Social interaction, - Social capital, - Group obligation, - Simultaneous cultivation	- Availability of feed for pest, - Pest population in the land, - Pest attack, - Paddy failed to harvest, - Paddy in Growing Stage, - Pest move out from the land, - Pest growth, - Population of Natural Enemies
Modern Agriculture Practices	- Chemical pesticide application - Synthetical fertilizer application - Intensive cultivation - Paddy Grain Sales	- Pest adaptation, - Pest resistance, - Natural predators killed, - Population of Natural predators, - Pest population in the land, - Pest attack

The practices of industrial or commercial agriculture should be tending to compromise between present and future productivity. The ways in industrial agriculture puts future productivity at many risk [14]. Agricultural resources such as soil, water, and genetic diversity are overdrawn and degraded, human health suffers, and the social conditions are weakened and dismantled to resource conservation

Personal curiosity and willingness to learn, together with social networking among farmers and community, and supportive formal knowledge and governance structures, are all important learning points for success in social and ecological aspect [3]. Human as decision maker have to manage their ecological aspect in order to improve economy and welfare.

4. Conclusion

The values of traditional agriculture practices in Mekarjaya village were shifted gradually from food security purpose to food commercialization in line with the modernization technology in rural area. Trajectory of integration between traditional practices and modern practices in the last four decades is very dynamic. Technically all of modern technology can be adopted as long as economically profitable and efficient, meanwhile traditional knowledge practices which are still maintained about social ritual related to paddy farming system. Farmer relationship now is more distant than in the past, as relationships grow in trust, now social institution grows weaker because trust in social capital has been depleted.

Social element in local agriculture practices looks more respect to environment than that of modern agriculture practices, while social element in modern agriculture tend much more to economic aspect. These force commercial agriculture to compromise between present and future productivity for sustainability reason. Personal curiosity and willingness to learn, together with social networking among farmers and community, and supportive formal knowledge and governance structures, are all important learning points for successful in social and ecological aspect for sustainable agriculture development.

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