

## Sociotechnical Change and Institutional Adjustment in Paddy Rice Farming During Post Green Revolution in Indonesia

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**Abstract:** The development of rice field agriculture in Indonesia has entered the post green revolution phase. The sociotechnical changes occurred during the green revolution, the economic gap among farmers also ensued amid the increase in production while the social sustainability was maintained. The research purpose is to analyze the institutional adjustment conducted by the farmer society in facing the problems caused by green revolution in order to maintain the social sustainability. For the purpose mentioned above, the case study was carried out in a village in a center of green revolution. The result of the research shows that: (1) The sociotechnical changes had been taking place during the pre-green revolution era, green revolution, and post-green revolution in the form of land management, seeds procurement, planting and managing the crops, and harvest and post-harvest. The sociotechnical changes encouraged the increase in agricultural production in which created the gap between the affluent and the underprivileged in a village and had the potential to disturb the social sustainability of rice field agribusiness. (2) The institutional adjustment occurred in the sociotechnical changes in the forms of land ownership dynamics, employment dynamic and village's new occupation dynamic. This institutional adjustment has the function to dampen the tension on the marginalized individual actor caused by the post green revolution new social structure. (3) The social sustainability in the rice field agriculture could be maintained because the social tension caused by the post green revolution social technical changes could be dampened by the institutional adjustment. The institutional adjustment by the village community contributed into the social sustainability of the rice field agribusiness.

**Keywords:** socio-technical changes, institutional adjustment, post green revolution, social sustainability

## 1. Introduction

The Indonesian government during the 1970s to 1980s carried out the green revolution and it determined the sociotechnical changes in multiple aspects of rice field agribusiness (Collier, 1974; 1978; Husnah *et al.*, 2014). The terminology of green revolution in this context refers to the agriculture technology change that is so rapid and fundamental that a significant change occurs in crops production and productivity especially in rice field (Biswanger and Ruttan, 1978; Poerwanto *et al.*, 2012). For Indonesia, the green revolution contributed hugely in bailing out the population from the starvation threat in the 1970s and in assisting Indonesia to achieve the food self-sufficient in 1980s.

The study on the green revolution effect on the village community social economic changes shows two different findings. First, the finding with the neutral perspective that showed the introduced technology provides the similar benefit for either farmers with small size farm and those with large farms (neutral-scale) (Feder and Umali, 1993; Feder, 1980). It shows that even though the production cost and production result between the large field farmers and small field farmers are definitely different but both achieve the increase in production and productivity in the pre and post green revolution (Jewitt and Baker, 2007). Even the study on the effect of genetically modified crops in Africa also concludes that this technology is neutral scale and can be a key driver in the transformation of small field farmers (Juma, 2013; Collier and Durcan, 2014).

Second is the study result with the perspective that the green revolution provides

benefit in bias scale. The findings show that the green revolution only provides huge benefit to the large scale farmers and the capital-based economic actor in the village but only provides little benefit for the small scale farmers (Fischer, 2016), even in Asia and Africa the green revolution contributes in increasing number of landlessness and poor landholders population (Dawson *et al.*, 2016). According to Fischer (2016), technology does not recognize the difference of land scale of the farmer that adopts the technology but the green revolution social shaping perspective is also related to politics, biology, ecology and social structure, and the bias scale of the technology may occur.

In Indonesia, Hayami and Kikuchi (1987) found that the technology bias of the green revolution causes changes in the social structure of farmer community that led to the worsening of social stratification leading to social polarization formation. Hayami and Kikuchi (1987) concluded that the direction of social changes in Indonesian villages during the green revolution was at the crossroads of the worsening of social stratification and the formation of social polarization. Amaluddin research (1998) also concluded that the social polarization occurred due to the green revolution but it did not create conflict between the large-scale farmers and the small-scale farmers because the strength of traditional collective institution in the village and the existence of vertical solidarity in the patron-client bond between the large-scale farmers and small-scale farmers.

In the 2000s, after the end of green revolution, the sociotechnical changes kept on occurring in the rice field community. Even

though the government did not provide significant assistance in the form of production infrastructure and agriculture counseling in encouraging innovation adoption, farmers took advantage of the market mechanism to continue using quality seeds, chemical fertilizer, pesticides, and improving planting technic (Salman, 1995). These caused the increase in production and farmer income sustained in the post-green revolution and continuation in the worsening of social stratification and social polarization process due to economic gap between large-scale farmers and small-scale farmers. However, the economic gap among farmers did not trigger the social clash in the farmer community (Salman, 1997), and this the agriculture development social sustainability could be maintained. What kind of factor at work, that even though the economic gap triggered the worsening of social stratification and create social polarization, kept the farmer community in harmony and the rice field agriculture can sustain socially? By referring to the Marxian hypothesis, when there is an economic gap in the farmer community that is followed by social gap then the class conflict potential is humongous (Landsberger and Alexandrov, 1974; Paige, 1975). One of the hypotheses that can be put forward is the existence of institutional adjustment that simultaneously taking place with the social technical changes and social structure changes that the problems crated by social technical changes and social structure changes can be neutralized via institutional adjustment.

According to North (2008) institution is basically the rule of the game in the collective goal achievement in life. Institution

at the village level involves a set of rules of the game that stemmed from the domain of local government, local community and local market, in which various actors fight for their interests (Uphoff, 1988). Hounkonnou *et al.* (2016) finds that agriculture innovation holds an important institutional dimension that means innovation has the emergent property of the purposive interaction among the stakeholders in a certain system, including the agriculture domain. Therefore, if the stakeholders with the interest in the agriculture development can adjust the rule of the game in various relationships among themselves that they can adapt to the problems arise due to the technology bias introduced by the green revolution, the social sustainability of the farmer community can be maintained. This research commenced from the discussed assumption.

The research objectives are to describe the sociotechnical changes that occur during the post green revolution in Indonesia and to analyze the institutional adjustment context that adapt to problems created by the aforementioned sociotechnical changes that the social sustainability of the farmer community can be maintained. The findings of the research are expected to contribute in the concept development of institutional adjustment in achieving rice field agriculture social sustainability.

## 2. Materials and Method

The research design is a case study and the case unit is a village. The selected case village is Bonto Marannu Village, Lau Sub District, Maros District, South Sulawesi Province, Indonesia. Maros District was the

first district to experience green revolution in South Sulawesi. In this area, there was an Agriculture Research Office that in the 1970s had a very important role in producing and spreading the field rice innovation. The selected village was a village that significantly experienced revolution in the area. The research was conducted in 2016.

The data was collected via in-depth interview with several landowners, farmer association managers, rice milling unit operator and owner, hand tractor and combine harvester entrepreneurs, rice vendors, planting labor, permanent labor, and rice grain porter. Half of the informants were selected purposively and the other half was selected with the snowball sampling technique. Participant observation was also conducted either in a special interview or collective interview. The in-depth interview and participant observation were conducted in the farmer residence, rice field, rice-milling unit, and the activity area of planter labor and permanent labor. The triangulation technique was applied to verify the data validity of the informants.

The data was analyzed comparatively based on the agriculture modernization period in Indonesia. The characteristics of the sociotechnical changes were compared based on the period before the green revolution, during the green revolution, and post green revolution. The institutional changes were identified in the classification of before and after the occurrence of sociotechnical changes. Based on this analysis, the institutional adjustment was positioned as the response toward the problems created by social technical changes

### 3. Results and Discussion

#### 3.1 Sociotechnical Changes

Socio-technical condition in rice farming is an integral work processes consisting of technical systems and social systems that produce agricultural production. Linkage technical dimension and a social dimension as an organization paddy production formed socio-technical systems (socio-technical system). The system consists of a group activity production processes that take place on the arena of biological processes rice plants in a natural environment and social environment. The green revolution in the village of Bonto Marannu has brought socio-technical change on all cluster rice farming activities, namely land preparation, seeding, planting, maintenance, harvest, post-harvest. Changes in socio-technical characteristics of the phase of pre-green revolution, when the green revolution and the post-green revolution in the village can be summarized as in Table 1.

Table 1 shows various forms of socio-technical change in Bonito Marannu on the pre green revolution, during green revolution and post green revolution. The sociotechnical changes on the land management indicated the shift from the employment of animal labor to the machinery. The existence of tractor enabled farmers to work the land twice in a year and this led to multiplied production. However, on the other hand, the land was fully occupied the whole year and there was no more space for water buffalo herding. This implicated the disappearance of water buffalo population from the village world because the function was replaced by the tractor. The time and space for herding also diminished because the rice field

**Table 1.** Socio-technical change at various stages of rice paddy farming activities

No	Activity	Pre-Green Revolution	On Going Green Revolution	Post-Green Revolution
1.	Cultivation Soil	Manpower involves manually in plowing the fields by clicking on the use of buffaloes and cows. Operational plow rice fields involving mutual aid among workers and livestock farmers. Livestock are also air as a function of asset farmers as a source of protein or for cash	-Mini tractors and hand tractors began to be used. The land could be cultivated twice a year, fallow land for animal feed narrowed, buffalo and cattle population decreased. Mutual aid among farmers began to be replaced by the rental of tractors and tractor carrier wages	Entire tillage already used hand tractors. The role of farmers' households and communities in the processing of land taken over by the tractor business. Ecology tillage change of buffaloes and cows to the engine and fuel
2.	Seeding	Local seed: longevity, plant height, no response to fertilizer, pest and disease resistant, low production, good taste. Seeds prepared by the farmers themselves in a long time (25-30 days) with full treatment ritual sacred honor. Among farmers be mutual give and exchange of seeds and planting the seeds are carried out in cooperate	Seed excel: short-lived, low plant, the production medium, response to fertilization, pest and disease prone and high production. Yielding seeds obtained from government assistance. Ritual handling of the seed is not done yet, but farmers remain in his honor by not resell seeds among farmers continue giving and barter seeds.	Seed certified superior: short-lived, low plant, high production, response to fertilization, pest and disease resistant, drought resistant. The seeds produced by seed companies, farmers bought through farmer groups with a price that was subsidized by the government. Sacral treatment on seed starting abandoned by the farmers, the seed has become a commodity bought and sold
3.	Sowing	Seeds in the soil by walking step as he backed away. The number, spacing and regularity row planting seeds that been pierce and overlooked. Planting is done with the wrapped-family members as well as personnel exchange and mutual assistance with other farmers	Seed is plugged by walking backwards on the line while planting has been aligned with the rope. Number of seedlings once step, plant spacing, and regularity row-column noted. Besides family members and citizens village, farmers begin to use wage labor	Seed is pierce by walking and backward in a row that is aligned with the strap. The number of seeds per step on the set 1-3 stems, spacing of 20-25 cm, column-row regular. Planter wages are paid the same price to pay the builder, the involvement of relatives and neighbors are paid by the piece
4.	Plant maintenance	Maintenance is not intensive: rain-fed water regulation, replanting with a considerable amount, control of weeds manually, manure stocked up before the rains, pest and disease physically and fumigation. Because the age of the plant long then there is spare time on a maintenance period used by farmers to earn a living outside the farm	Intensive Maintenance: irrigation water is managed technically, replanting by-limit, synthetic fertilizer three times with a single fertilizer, pest control the physical and chemical, pest and disease control using pesticides and insecticides engine with the spray equipment. Labor outside the household is not in-engage; farmers do not have time to find off-farm income. Paddy rice ecosystem polluted chemicals	Extensive maintenance: irrigation water is managed technically, replanting in small amounts, fertilizing synthetic three times during maintenance with a single fertilizer and compound fertilizer, control late weeds physically and chemically, pest and disease using pes-insecticides and insecticide to spray equipment engine, Outside of the household labor were excluded, farmers do not have time to find off-farm income. Paddy rice ecosystem polluted chemicals
5.	Harvest	Harvest cut with ani-ani: rice panicle cut with a knife while got way forward, after sufficient 10 handhelds tied with incision rope bamboo, transport to the farmer's house. Involves a lot of energy working women are coming from various regions. Apart harvest his rice farmers picking up eggs, catch birds, as well as taking various types of fish from paddy.	Harvest cut, slash and fall with sickle: rice cut down on the lower stem with a scythe, threshed by machinery, grain-kan dimasuk into sacks and transported to the rice mill. Labor involves men in considerable numbers. Workers hired harvesters began to form in the air group. Yields of followup such as eggs, fish and birds began to decre	Harvest combination slash, threshing and bagging by car crop: rice cut down, threshed and done at once by car harvest (combine harvester) owned by the investor. Manpower 3-5 people, comprising one operator assisted 2-4 workers organize rafting and lowering of the car. Works harvest taken by the machine. Yields of followup such as eggs, fish and birds dwindle
6.	Post-harvest	Panicles of rice in the bonds dried by hanging or by reversed are attached for 2-3 days, after which it is stored in the attic of the house farmers. Postharvest activities followed by processing the paddy into rice through the release panicles of rice, pounded in a mortar with a pestle, and cleaned with Tampi, by the power of women	Grain dried spread it on a pedestal plastic or drying floor for 2-3 days. After that stored in sacks or directly processed at the plant rice. Family labor and women are no longer involved inten-sive, activities post-harvest foreclosed by manufacturer.	Grain is dried on the floor drying or using machinery. Dryer is then stored or directly processed into rice. Processing is done rice milling unit small scale, medium and large start broken skin, filtering and cleaning time faster. Work post-harvest been full run by machines.

management that took place a whole year.

The sociotechnical changes in nursery indicated the shift in the function of seed procurement from farmers to the seed

provider companies. This implicated to the disappearance of indigenous knowledge of farmers in nursery and the emergence of farmer's susceptibility of seed supply



when the seed provision by the company experienced difficulty. The sociotechnical changes in planting indicated the shift of the occupation from family and farmer community to the hired labor and planting machine entrepreneurs. This implicated the emergence of commercialization in the planting work and the cultivation work that was previously the core of farmer existence became the commercialized service.

The sociotechnical changes in the crop cultivation indicates the intensifying of chemical materials in agriculture via the fertilizer and application of pesticides. This implicated the increasing pollution of rice field ecology by chemical materials and led to the diminishing of other products of the rice field like fish and bird. The sociotechnical changes in harvesting indicates the shift from the manual labor by women to machineries operated by males. This implicated the shift of females' occupation from the agriculture work and the transformation of harvest occupation to commercialized business.

The sociotechnical changes during the post harvest activity indicated the shift of harvest technology from the characteristic that was appropriate for female labor to the sophisticated machinery operated by males in the business system. This contributed to the loss of occupation for females in agriculture due to the function was taken over by rice milling unit.

Behind the increase of products and productivity achieved through the green revolution, the sociotechnical changes occurred and dismantled the relationship between animals and human in the farming, disassemble the gender relationship in farming and trans-

formed the village subsistence economy into commercial economy for entrepreneurs. Therefore, besides the bias scale in providing benefits for the large scale farmers as indicated in various studies, the green revolution also provided an effect in dismantling several relations among actors in the previously institutionalized in village environment.

### 3.2 Institutional Adjustment

Along with the various changes in the socio-technical, institutional adjustments in various aspects of village life are also underway. Institutional adjustments that can be divided into three major aspects namely: institutional adjustment in response to the dynamics of land tenure, institutional adjustments in response to the dynamics of employment and institutional adjustments in response to the growth of new occupations.

Institutional adjustment takes place in a land tenure rules, *penyakapan* (profit/output sharing) of land, land liens, sale and purchase of land, inheritance of land and using the land as a marriage dowry. In sharing product of land, the current processing cost of land, production facilities, maintenance and harvest are shared between the landowner and *penyakap* and the harvest divided by two. Previously, the costs of the means of production are borne by the owner of the land, labor costs borne by *penyakap*, and the harvest divided by two. In the system of land lien, pawned give gold worth to the owner of land and the right to use the land is own by pawned is in season number according to mutual agreement, which worth of gold will be returned to pawner after the lien expires. This rule does not change be-

fore, during and after the change of socio-technical. In terms of buying and selling land, the market mechanism in determining the price and the formal legal framework on the legality of ownership become the general rule. Previously, the sale of land occurring on lands that are not able to pledge redeemed by their owners so pawned simply add value to satisfy the lien sale price.

In the case of inheritance the land, the old patterns of land passed down in the form of plots to some heir, the new pattern of land assessed by the value of money and the money distributed to a number of the testator. In the old socio-cultural system, the marriage dowry of men to women is in the form of land, but nowadays the form of a marriage dowry is money.

Institutional adjustment of employment takes place in the form of abandonment of the rule of mutual help based romance and family boundaries become calculative rationality in the wage system and rental system. Before changes in the socio-technical occur, tillage, planting, maintenance is done in the mechanism of mutual aid and barter power between farmers, while the work of harvest involves female employment in the village and outside the village extensively where wages received in the form of grain are suitable on the amount of capable harvested. Currently, all the work is performed under the rules of wage labor and machinery rental cashless.

An institutional adjustment in response to new occupational growth takes place in the form of increasingly functional business unit of cultivation, harvest and processing of product implementation. Contractor's till-

age grows by relying on the operation of the tractor to get paid work and machinery rental of land owners. Contractor crops grown by car combine harvester finish the harvest landowners. Business is growing increasingly modern rice mill in processing paddy to rice. Occupational units recently taken over functions previously carried out by the family institution and community agencies that base is voluntary. New occupational units are growing up in the rules of market mechanisms and profit-oriented. An acceptances of the market mechanism and profit orientation by institutional adjustment from voluntary abandonment of the institutional mechanisms in family and community boundaries.

### *3.3 Sociotechnical Changes, Institutional Adjustment and Social Sustainability*

From a variety of socio-technical changes in Bonto Marannu, lasted two processes that could potentially give birth to some social turmoil. First, the birth of the capitalist social formation as a substitute for subsistence social formation. Agricultural mode of production has previously worked with simple technology-based production, which strength and orientation of production is to meet the needs of subsistence, then transformed into a force-based production machinery and production orientation to find profit. This is followed by a change in the social relations of production based on kinship and patron-client to be based on employer-employee relationship. In addition, the exclusion of women also occurs in harvest activities and the reduction of male labor for machines that are more significant role. Second, the economic disparities and

social polarization. Increased productivity of paddy rice after a socio-technical change occurs to make the population of the rich getting bigger. If before the top layer is only filled by large landholders, after the revolution filled the top layer of the newly rich soil processing power supply, power supply planting, harvest service owner, and the owner of rice milling units. Meanwhile, the poor rural population also increases. If previously poor village consisting only of small farmers, post green revolution plus the poor villagers by village workers thrown out of work communally farming and replaced individual effort based machines

In the Marxist perspective, the presence of the capitalistic system, followed by social polarization will encourage antagonism between classes with a class of land owners who do not own land. In fact, the class conflict does not occur in Bonto Marannu. Study of agricultural sociology as practiced by Hayami-Kikuchi (1987), Amaluddin (1988) and Triyono and Nasikun (1992), Dowd-Urube (2014) and Wald (2016) concluded that the explosion of class conflict in the countryside behind economic inequality since the green revolution caused by strong ties traditional villages and familial solidarity. In this study it was found that kinship and mutual aid will no longer be a basis in the farming. So what factors that inhibit economic inequality and social polarization, that do not cause social upheaval in Bonto Marannu?

As it seen from Bonto Marannu cases, the institutional adjustment has been functioning as a safety valve in defusing potential conflicts behind economic inequality and social polarization caused by the green

revolution. Institutional adjustments in response to the dynamics of land tenure, employment dynamics and the dynamics of a new occupation in this retrospective case series have been functioning so. In the case of the peasant response to climatic and economic changes, Feola (2017) have a same conclusion and promote the adaptive institutions concept. In a broader perspective, the institutional adjustments that have kept the social sustainability of rice farming from before green revolution era, during the green revolution and after green revolution. As emphasized by Hayashi (2012) and Carreon, et al (2012) that social sustainability is one of the pillars in the sustainability of agriculture, this study shows that one of the factors that can contribute to social sustainability is the institutional adjustments.

#### 4. Conclusion

Some principal findings are (1) the socio-technical change took place from the pre-phase of the green revolution, during the green revolution and the post era of green revolution in land preparation, provision of seeds, planting and maintenance of the plant, and harvest and post-harvest. The socio-technical change has driven an increase in farm production, hence the birth gap between rich and poor in rural as well as potentially disruptive social sustainability of rice farming rice fields, (2) Institutional adjustment has been running behind the ongoing socio-technical change in the form of institutional adjustment to the dynamics of land tenure, employment dynamics and the dynamics of a new occupation in the village. This institutional adjustment has to work to



defuse tensions on the individual actor marginalized by the new social structure of post green revolution, (3) Social sustainability in the farming of paddy can be maintained because the social turmoil caused by changes in socio-technical post-green revolution can be mitigated by the presence of institutional adjustment. Institutional adjustments by rural communities to contribute to social sustainability of rice farming rice fields.

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