Advances in Social Science, Education and Humanities Research, volume 465
Proceedings of the 1st Annual Conference on Education and Social Sciences (ACCESS 2019)

Local Wisdom of Farming by Small Farmers in Rainfed Dryland of Pelat Village

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***Abstract*—** Dryland farmers have local wisdom knowledge on food crop-based agricultural system for generations. This research aims to learn local wisdom of traditional rainfed agricultural system by small farmers in rainfed dryland. The research is done from January to February 2019 in Pelat Village, Unter Iwes Sub-district Sumbawa Regency, West Nusa Tenggara Province. The research population comprises dryland farmers who still conduct traditional system farming of 100 respondents. Farmers' local knowledge is documented through individual interview as well as interview with dryland farmer groups in Pelat Village. The research results explain that most small farmers still maintain the local wisdom in determining planting time, land preparation, planting and harvesting by looking at the stars, natural condition, and crops. Local wisdom to cope with limited factors of dryland that are part of soil conservation include construction of terrace, *rorak*, ditch, and mound, and water conservation with rainwater harvesting ponds. Local wisdom of *gotong royong* (mutual assistance) is conducted using *besiru*. Farmers have high motivation to maintain the traditional agricultural system due to its low financing, seedlings that are more resistant to diseases since it is used for generations, and planting intensity for once a year. Factors influencing the motivation consist of education, farming experience, arable land area, and number of family dependents.

***Keywords*—**Local wisdom, conservation, dryland

I. INTRODUCTION

The achievement of food security is one of supporting pillars of the sustainability of Indonesian nation [1]. The government of Indonesia declares food self-sufficiency in 2014-2019 [2] with rice self-sufficiency in 2016 and it must be maintained in the next years [3]. Land availability and agricultural land extensification become a determinant factor of success to maintain the food self-sufficiency and to achieve Indonesia as a world food bar in 2045 [4].

As a national food barn region, West Nusa Tenggara Province makes an effort to increase rice crop yield to meet the increasing food needs of the population. Improvement in agricultural land productivity is one of efforts to enhance food security in the NTB province [5]. Food crop yield optimization could be conducted in dryland agro-ecosystem [6]. Agricultural dryland area is 87,232 Ha and 15,786 of it is rainfed land [7].

Rainfed dryland is a potential resource for agricultural development. Rainfed ricefield is generally planted with *gogo* rice once a year, which is in rainy season, whereas in dry season some of the land area left as a fallow land until the next planting season. Food crop yield increase highly depends on rain water in dry land [8]. Rain is the main source as well as a limited factor of crop yield in dryland. The average precipitation in Sumbawa regency for the last 16 years is relatively low with uneven distribution (117,46 mm/year) [9].

Climate change impacts rainy season time that is unpredictable. Determination of the beginning of rainy season for planting time in rainfed dryland is vital since failure in early rainy season forecast will bring crop failure and food vulnerability. Water management is important in land management [10]. In addition to its ability to encourage economic improvement due to an increase in land productivity [11,12] and community prosperity [13] water available for plants is also ecologically beneficial since it creates water balance [14].

Pelat Village is one of villages that has rainfed lands with traditional agricultural system that maintains knowledge from generation to generation, especially in rice farming. The rice farming is conducted by most of small farmers. Small farmers are people who involve in farming in small land area (less than 2 ha), grow food crops that sometimes with small varieties of commercial plants and they are the largest proportion of 570 million agriculture in the whole world [15,16,17]. In addition, they practice mix farming of crop and livestock with the number of large ruminants raised approximately 3-5 [18], the farm is managed by family workers and it is to support the family internal needs.

Rainfed rice is a superior commodity of Pelat Village [19]. The commodity superiority supported by input (production facilities) availability and affordability o farmers' purchasing power of inputs affect farming performance managed by farmers [20]. Farmers' cultural change as well as ecosystem change have impact on the rice crop genetic diversity that is dramatically reduced or lost [21,22,23].

The Pelat Village farmers, as main actors who are familiar with farming environment, have wisdom (farmer wisdom) in farming in a marginal rainfed land. Additionally, the farming adapts to local ecosystem and gives positive contribution to environmental management. The wisdom then becomes a foundation in adopting information and technology so as produces a local knowledge suitable to local agricultural condition. Small farmers have knowledge to overcome climate change and variability by identifying local vulnerability and select an appropriate adaptation in accordance with their own capacity [24].

Information exploration on community local knowledge and innovation adopted by farmers could illustrate management pattern of natural resources in its surrounding; therefore it is easy to apply by other communities. At the same time, farmers could receive and take benefits of the knowledge to develop their knowledge and to be applied by other farmer groups that never apply it. This research aims to learn farmer local wisdom in managing marginal dryland and innovation adopted to conserve soil and water to reduce climate change impacts.

II. METHODS

The research was conducted at Pelat Village, Unter Iwes Sub-district, Sumbawa Regency, West Nusa Tenggara Province from January to February 2019. The research used descriptive approach with survey technique. Farmer respondents in the research were selected using purposive sampling and convenience sampling with number of dryland farmer respondents of 100 respondents. The respondents were selected using criteria: 1) farming is the main job; (b) live in the Unter Iwes Sub-district area; (c) they become member of dryland farmer group and are recorded in BP3K of Unter Iwes Sub-district; and (d) they have arable area of 1-2 ha. Data collection was conducted using survey technique through interview with the respondents. The main questions included local knowledge that is still being used up to now in the traditional system of rainfed rice.

In-depth interview with informants were conducted that comprised local knowledge practiced in terms of information on planting time, soil and water conservation efforts, farmer motivation in maintaining traditional system, the use of local seedling, efforts to maintain crop intensity, and factors related to farmer motivation in maintaining traditional system of rainfed rice. Direct observation was performed to obtain information on farmers' local knowledge that consisted of planting time, namely: what time is the planting time, how soil and water conservation practices are applied, what kind of *gotong royong* activities that are still conducted, and what are farmer motivations regarding their desire to maintain the system. All responses were analyzed using descriptive-qualitative method.

III. RESULTS AND DISCUSSION

Local Wisdom to Determine Planting Time in Traditional System of Rainfed Rice

The research results indicated that cultivation conducted by respondent farmers used knowledge passed on for generations based on ecosystem, climate, and events closely related to human and nature. Human interaction and nature brought about local wisdom of preventive measures, precautions for difficult events, ability to predict, mitigation and prevention that were passed on for generations based on lineage. The community knowledge passed on consisted of weather dynamics, organism behavior, and sky objects movement.

The farmers were meticulous in observing an appropriate season to determine the right time for land cultivation and rice planting. Stars appearance, the change in sky color, bird sounds were indicators to select an appropriate time to conduct each of rice farming steps. The appearance of star in the eastern horizon at dawn coincided with the dry season, which is a time for farmers to prepare land to plant rice. Farmers started to prepare land to be used for planting by burning them and the burning residue was believed to be a fertilizer to fertilize the soil. Stars appeared above the head or sloped slightly to the west was usually a sign of the beginning of wet season thus an appropriate time for farmers to start rice planting. Another sign could be seen from the crop was the emergence of new shoots in the west part of the tree. It was a sign that cold wind came from the west and a sign for the beginning of rainy season. If stars could not be seen from the west horizon, then the planting season stopped. By observing the signs the planting and harvesting activities could be done at the same time. Several reasons for maintaining the local knowledge included: low-cost farming, easy crop maintenance, and the use of local seedlings that are durable and resistant to diseases thus produce yield and income that could fulfill family's life necessities until the next season [25].

Local Wisdom of Soil Conservation Techniques in Traditional System of Rainfed Rice

The research results indicated that there were several local wisdoms that were particularly intended for overcoming land limited factors that affected harvest. The construction of terrace, *rodak*, ditch and mounds are one of soil conservation efforts by farmers. The Pelat Village topography was generally at the slope level of 8-15%. It was particularly in soil that was prone to erosion. The soil conservation efforts aimed to prevent erosion by rainwater so as to improve soil fertility and maximize crop yield in short term [25].

Farmers used rocks in the land to expand the cultivated area. The rocks were arranged by cutting the slope or following the contour line; thus, it could slow down run-off and inhibit erosion. Surface rocks as an obstacle factor became useful for soil conservation. The arranged rocks could serve as a barrier to prevent fertilizer for not carried by water flow. If the land had no expanse of stone, then farmers used trimmed branches of *gamal* tree to reduce erosion. The branches were put by cutting the slope served to inhibit the run-off rate.

On a land influenced by old cultivation, farmers arranged a stone terrace better. The process of simple terrace construction could be done gradually according to farmers' ability. Some farmers described the benefits of the terrace

as: (a) inhibits water flow on soil surface thus reduces soil erodibility; (b) collects topsoil washed away from the land. Soil layer often carried away by water is the topsoil, which is a fertile soil layer. Due to the terrace, the fertile soil eroded by surface runoff would not washed away but it would be collected by the terrace underneath; (c) facilitates farmers in managing their land, especially in harvesting process.

Soil conservation efforts in area that is prone to erosion were a priority to maintain land productivity sustainability in a short term and to prevent a decrease in soil productivity in a long term. One effort to decrease run-off was by reducing slope that could be done through terrace construction, bench terrace or ridge terrace, and planting according to the soil contour. Farmers who experienced a decrease in yield and those who lived in dryland, however, had a significant influence on opportunity of farmers' decision to change the planting pattern and shift the planting time as a form of adaptation to climate change.

Local Wisdom of Water Conservation Techniques in Traditional System of Rainfed Rice

The research results suggested that water conservation conducted by dryland farmers during a short term, high intensity rain was by collecting and utilizing the rainwater optimally, minimizing water lost, and collecting rainwater to be channeled to temporary and/or permanent reservoirs that could be used to water the plant at any time when needed.

Kuang is a pond to collect rainwater. *Kuang* could be used by farmers to water the plants, as a drinking site for livestock or as a fish farm. The local wisdom of *kuang* system was intended to (1) reduce run-off volume and increase groundwater reserve; (2) increase water availability for plants, especially during dry season; and (3) reduce run-off velocity thus its scrape and carrying capacity decrease.

Water harvesting is useful to fulfill plant's water requirement thus some parts of land could still produce during dry season and it also reduces erosion risk during rainy season. The water harvesting technology is needed in an area with the following characteristics: (a) dry climate (> 4 month consecutive dry throughout the year or 3-4 months without rain; (b) food crop yield is limited due to low water availability in the soil; (c) all lands are sloped (corrugated to hilly land) with bad soil physical condition, thus it could not store water for a long time; and (d) wet climate area that has water critical period [26].

Local Wisdom of Planting System with Besiru in Traditional System of Rainfed Rice

Besiru to conduct *gotong royong* tradition is one of social behavior forms of Samawa people (Samawa tribe). It relates to solidarity between people in conducting land work and it is done from one land to another. In other words, people conduct *gotong royong* to complete a work consecutively until harvesting work is done. Dryland farmers conducted land cultivation and planting works in a group. One group usually consisted of relatives who had land to be cultivated and planted. The group included male and female of 7-25 people depended on the land area to be worked on. Planting work was mostly done using *tugal* (a wooden stick or else that has sharp edges to make a planting hole) with an order from the group leader or the elder. The *besiru* was conducted to strengthen kinship between the family members.

Farmer Motivation to Maintain Farming Local Wisdom with Traditional System

The research results on farmer motivation in maintaining farming local wisdom with traditional system consisted of: a) farmers had high motivation due to local knowledge that was in line with environment in determining appropriate planting time during rainy season and a low-cost farming was mutually agreed that traditional system was maintained; b) farmers had moderate motivation since there were government efforts to increase yield through area expansion and irrigation facility development; thus, it gave an option for farmers to still use local knowledge when sufficient rain was available to fulfill the plants' water requirement during plant growth period and adopt the technology once the irrigation facilities had constructed. The option was taken since climate condition had high variability and the government policy regarding food crop yield enhancement through irrigation facility improvement encouraged the people to obtain the benefits; 3) low motivation related to farmers' desire to use irrigation since water would be available continuously regardless the season (rainy season). Farmers had abilities influenced by their motivation and participation to join a farmer group, interaction, information, source and dependency on land [27].

Farmer Motivation to Maintain Local Seedlings

According to the research results, farmer motivation level to maintain local seedlings was in a high category. It was due to the use of local seedlings for generations. The seedlings were resistant to diseases; thus the yield increased. Local variety rice was adaptive to the local environmental condition; hence, it cultivated well. The farmers, however, had a desire to try tolerant-to-drought seedlings thus reduced harvest failure risk due to climate variability. The use of a cultivar tolerant to drought in the area could be a good strategy to encounter unpredictable climate condition in the future [28].

Farmer Motivation to Maintain a Once-a-Year Planting

Based on the research results farmer motivation level to maintain a once-a-year planting was high. It was related to the fluctuating rain condition that caused planting could only be done once a year. Moreover, farmers preferred other farming after harvesting or changed the ricefield function into a pond than replanting the land with rice. It was conducted to prevent pest and maintain soil fertility. Due to advancement in technology, however, farmers also had desire to try rice planting twice a year in a condition that it was conducted by all farmers simultaneously since it could bring loss due to pest if only few farmers conducted the system.

Factors Related to Farmer Motivation to Maintain Traditional System

The research results indicated that there were factors in maintaining the traditional system, namely:

1. Formal Education
   Formal education had a relationship with farmer motivation in maintaining traditional system. The higher the farmers' level of formal education, the more developed their knowledge since they kept up with a more modern technology development, namely the implementation of irrigation or the use of technology to increase water availability that could enhance planting intensity. Low educated farmers would find some difficulties in making a decision regarding allocation of their resources. The level of education of Pelat Village farmers was low and it affected their decision making in their farming management activities [29].

2. Non-Formal Education
   Education had a relationship with efforts conducted to maintain the traditional agricultural system. If farmers had a non-formal education, they would have knowledge to make a decision. Non-formal education received by farmers through extension and training was in minimum intensity; thus, knowledge received from the programs had not brought significant benefits. Farmers opined that extension was mostly conceptual and impractical. Farmers were thus less enthusiastic to join the extension. Participation in the agricultural extension activities, training or courses could improve farmers' knowledge and skills. The higher the frequency of participation in agricultural extension, training and courses, the faster is the implementation process of new innovations or change [30].

3. Traditional System Farming Experience
   On average, farmers conducted farming since their childhood; therefore, the longer the farming experience using traditional system, the more their motivation to maintain the traditional system of rainfed rice. The experience in traditional system faming had a significant influence due to farmer interest to conduct rice farming. New rice farmers or old rice farmers both had the same goal, which was fulfilling their life necessities using local seedlings. It was related to their habit in conducting their job and farmers also had a sense of togetherness in a once-a-year planting and responsibility to their job.

5. Arable Land Area
   Most farmers had a land area of 0,5-2 Ha; thus, the more the arable land the less the farmer motivation to maintain the ricefield traditional system. It was due to the more the arable land the more the number of yield that likely to produce; thus, the higher the risks due to vulnerability to climate change.

6. Number of Family Dependents
   The number of family dependents of the farmers was 5-7 people in a productive age to work; therefore, farmer motivation to maintain rainfed rice system would increase. The reason was that farmer assumed that the large number of dependents could help in farming; hence, the more the number of dependents the more who could participate in works that required a lot of labor.

IV. CONCLUSIONS

Local knowledge owned by farmers for generations had adapted to environmental condition as an effort to maintain land productivity sustainability in a short term and prevent a decrease in soil productivity in a long term. The Pelat village farmers' local wisdom that maintained local knowledge consisted of: determining planting time, preventing erosion through the construction of terrace, *rorak*, ditch, mounds and water harvesting site. Famers had high motivation to maintain local wisdom of using local seedlings that resistant to pests and diseases and a once-a-year planting. The motivation was affected by education, farming experience, arable land area, and number of family dependents.

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