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PROCEEDING

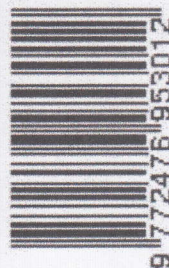
International Seminar on Science Education

Volume III

Enhancing Interdisciplinary Practice of Science
Education in the Realization of NGSS
(Next Generation Science Standard)



Proceeding of the International Seminar on Science Education Volume III



Graduate School
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Barik Yogyakarta Motif Semen Sido Mukti

Tugu Yogyakarta

October 28th, 2017



PREFACE

Praise to Allah SWT for all the blessings and guidance given to us all, so that the program of the International Seminar on Science Education (ISSE) 2017 with the topic about Enhancing Interdisciplinary Practice of Science Education in The Realization of NGSS (Next Generation Science Standards) which held on October 28th 2017 at Rectorate Hall, Yogyakarta State University can be completed successfully.

This proceeding is presented in four sections: 1) Science; 2) Physics; 3) Biology Chemistry; and 4) General Education. This comprises number of papers that have been presented in the seminar, written by lecturers and students from Yogyakarta State University and other universities.

We owe many parties for the success of the seminar. Therefore, we would like to sincerely extend our gratitude to:

1. The rector of Yogyakarta State University, Prof. Dr. Sutrisna Wibawa, M.Pd for facilitating all the activities of the International Seminar on Science Education (ISSE) 2017;
2. The director of Graduate School of Yogyakarta State University, Dr. Moch. Bruri Triyono for providing all the facilities of the International Seminar on Science Education (ISSE) 2017;
3. The invited speakers for their willingness to share thoughts and insights on science teaching and learning in the seminar;
4. All committee members for the time, effort, and thoughts for the success of this activity; and
5. All presenters and participants who have come a long way to contribute to the success of the seminar.

However, we truth fully understand that some imperfections might be find in this proceeding and in the seminar. Thus, suggestions and constructive criticisms are very much welcome. Finally, we hope that this proceeding may contribute in science and science education

Yogyakarta, Oktober 28th 2017

Chair Person

Prof. Dr. I Gusti Putu Suryadarma, M.S





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The Local Knowledge By Karo Ethnic In Doulu Village, Karo District To Intercropping Agricultural

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Abstract. This study aims to the documentation of the local knowledge by Karo ethnic in agricultural intercropping. The research method through participatory observation, interviews, and surveys. This research was done in August 2016. A total of 8 respondents were interviewed. The selection of respondents was done by purposive sampling with criteria as farmers who undertaken agricultural intercropping patterns of at least three years. The data were analyzed descriptively. Karo ethnic in the village Doulu do intercropping agricultural for the efficiency of land and to improve productivity. Intercropping is done by planting 2-3 species of the annual in the land simultaneously. Types of plants that are intercropping among others celery (*Apium graveolens*), leek (*Allium Porum*), chili (*Capsicum annuum*), cabbage (*Brassica* sp.), and tomato (*Solanum lycopersicum*). The main factor to consider selecting plants are age, canopy, and production of plants.

Keywords: *Apium graveolens*, intercropping, karo ethnic, local knowledge

1. Introduction

Karo highlands are the areas in North Sumatra with fertile soil, because the region flanked by two active volcanoes (Sinabung and Sibayak). The lands use by local communities in Karo highlands to agricultural are limited. To efficiency and to support of necessary, the local communities manage agricultural land by intercropping. Francis [1], stated that intercropping is the cultivation of two types of plants on the land in a time to increase the productivity per unit area. Intercropping is used to express to the application in multiple cropping [2].

Intercropping has been done by various local communities in Indonesia. The factors to influence of farmers to used that such as: limited of the land, the need of life [3], the efficiency of land and increase the productivity [1,4]. Various types of intercropping have developed by local communities, ie: sugarcane (*Sacharrum officinarum*) with soybean (*Glycine max*) by the Javanese (Rifai, 2014), corn (*Zea mays*) with peanuts (*Arachis hypogea*) [2,5], upland rice (*Oryza sativa*) with corn [4], rubber (*Hevea brasiliensis*) with banana (*Musa pardisiaca*) [6]. The plants selection to cultivate in intercropping are influenced by various factors, such as: the character of the land, primary productivity of the local community, topography, customs / culture of owned of land, age of the plant, and market demand [6,7]. Those resulted that pattern and type of intercropping are different in regions. The acctually of the farmers have used two types (species) plants in a area. The plants which used in intercropping are the annual plants with life cycle around 3-4 months such as: chili (*Capsicum annuum*), corn (*Zea mays*), rice (*Oryza sativa*), peanut (*Arachis hypogea*), soybean (*Glycine max*).

The plants productivities through intercropping no different than monocultur [3,4]. Dewi et al. [4] reported that intercropping upland rice with corn did not affect to productivity of upland rice but affect to a amount of light received rice, height, number of tillers, and weight of 1000 grain. Intercropping resulted to shade of the lower plants [4], so that the selection of plants are very important with plants specified criteria.

The main factors that influenced the local communities to done intercropping are limited land area [3]. The limited area is often found in various ethnic groups, like in Doulu village. The farmers in this village have the land area (garden) are around 0.5-1.0 ha for a household. The limited of the garden to inspired of the farmers to optimized of the land use and to increase income through intercropping.



This research was conducted to the documentation of the local knowledge in the Doulu village to manage of intercropping.

2. Methods

This research was conducted in August 2016 in Doulu village, Karo District, North Sumatra. Research carried out used the ethnobotanical survey and participatory observation methods. The respondents determined through purposive sampling with criteria are the farmers have done intercropping. Total eight farmers in the Doulu village in interviewed. Surveys were conducted with semistructured, open, and deep interviewed. Some things are asked to farmers, such as: the way of land preparation, rotation patterns on land, the selection of the plants, way to crop, maintenance of plants, and how to control pests and diseases. The data obtained were analyzed descriptively.

3. Results

3.1. Description Doulu Village

Doulu village is located at the base of the Sibayak volcano. The village is inhabited 430 households with 2.300 people. Local communities more than 90% are ethnic Batak Karo and remaining are Batak Toba ethnic and the other ethnic. The main income sourced from cultivation of celery (*Apium graveolens*), chilli (*Capsicum annum*), tomato (*Solanum lycopersicum*), and leek (*Allium porum*). The local communities have limited garden are 0.5 ha - 1.0 ha of a household. To efficiency and to increase the productivity of land the farmers are cultivate with intercropping.

Most people in the Doulu village are immigrants, so that haven't a land. To supplies of life its necessities, they rent of land from the people which have broad of land or from people which not activities agricultural. The rental price of land varies are 150000-200000 IDR for 10 m x 10 m, depend to distance of land.

3.2. Local Knowledge to Intercropping

Karo ethnic in the Doulu village managed their land in intercropping. The plants which used in intercropping are rice (*Oryza sativa*), celery (*Apium graveolens*), leek (*Allium porum*), peppers (*Capsicum annum*), cabbage (*Brassica* sp.), tomato (*Solanum lycopersicum*), corn (*Zea mays*), chives (*Allium* sp.). These species are routinely grown in rotation and alternately.

The irrigation system in the Doulu village actually been functioning properly to allow for the planting of rice (*Oryza sativa*) in the fields, but the respondents stated that the land is planted with rice paddy fields, the results are not sufficient to meet demand. Nevertheless, farmers in the village are mostly still doing activities in paddy rice cultivation. At the beginning of the land flowed with water to form wetlands. The land is planted with rice by the local people called the *page Cimen* (rice varieties *Cimen*). Rice has two characters who produce rice seeds are colored red and white colored rice. In taste white colored rice preferred by the people because fluffier than the red. Substitution intercropping with crops of paddy aims to break the pests and diseases that attack plants. Local communities state if not done pergiriran wetlands and dry land will occur pests and diseases that result in the failure of agricultural products, especially in plants that ditumpang extracted.

When they are wet land paddy rice farmers plant only, but now dry land farmers to variations in land that monoculture and intercropping. Farmers wisely determine the pattern of land that they till cultivation among farmers and between the adjacent land area. Plots of adjacent land planted with plant species are different. This causes variations in the harvest season, the type of intercropping. Here is the pattern of land preparation is done by local people in the Doulu village.

3.3. Monoculture

The farmers in the Doulu village have knowledge managed to cultivate the monoculture or intercropping. Although done monoculture, but the farmer tends to chosen of different plant species on land adjacent. This is done to cut off or limit the spread of pests/ diseases and to stabilize the prices of agricultural products. The plant what chooses to monoculture are celery (*Apium graveolens*) with leek (*A. porum*).

Celery is a main agricultural commodities in the Doulu village, because its regarded as a plant that suitable to be planted in highland (Figure 1a). The respondents said that to maintenance of celery relatively easy compared with the other plant. The celery can be harvest repeatedly in a long time.



Harvesting celery in the Doulu village done with taking a leaves that mature have a length more than 25 cm and colored dark green. The young leaves of celery allowed to keep growing. The harvesting celery in this research different from to farmers in West Java which conducted by depriving whole plant parts. Intake of mature leaves from plants resulted that shade plants that will reduce the flow aeration around the plants to be well and also provide an opportunity leaves that are easier to develop better. Harvesting is done about 1-2 weeks for 2-3 months.

Allium porum (leek) also of a plant that have been used in monocultures. Nevertheless, any of farmers who chosen *A. porum* in monoculture (Figure 1b). Harvesting leeks are once times suspected the factor that make farmers rarely use in monoculture. The morphology structure of *Allium porum* leaves are linearis that does not interfere with the shade to the other plant so that are more widely used in intercropping. The land plot that monoculture cultivate were covered with plastic which made holes with distance (30 cm x 30 cm) will be made perforation as a place to grow plants (Figure 1b). The purpose of land cover with plastic is to reduce weed growth as well as to maintain soil moisture, especially when the plants are young. The land cover with plastic is also considered to be practiser and cheaper in the field of process.

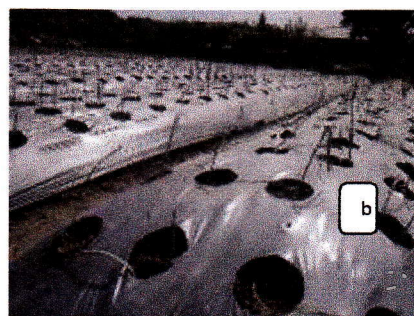
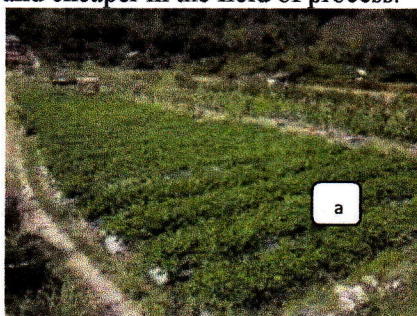


Figure 1. The monocultures cultivate in the Doulu village, Karo District, North Sumatra.

3.4. Intercropping

Intercropping cultivated the two or more of the plants types at the field in a time. The farmers in Doulu village modified of land to be plots which a smaller with size 0.8-1.0 m x 15-20 m. The number of the plots of land owned by the farmers varies depending on the farmer's capital. Plots are equipped with a small trench as limiting each plot. Empirically seen the moat serves to accommodate the excess water when the rainy season and also the weeds from the weeding.

Types of plants selected by farmers in intercropping vary among others celery, leeks, peppers, tomatoes, and cabbage. The model of intercropping uses two types of plants are: cabbage (*Brassica* sp.) with tomato (*Solanum lycopersicum*); celery (*Apium graveolens*) with leek (*Allium porum*); cayenne (*Capsicum annum*) with lettuce (*Lactuca sativa*); leek (*Allium porum*) with cabbage (*Brassica* sp.) (Figure 2).



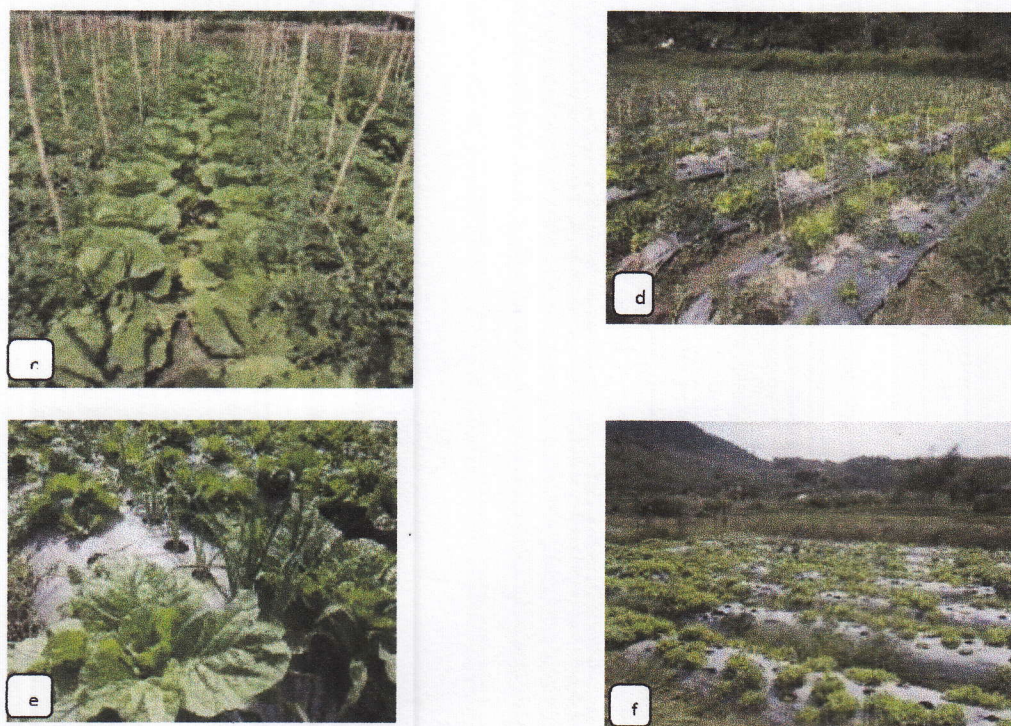


Figure 2. The pattern of intercropping by cultivate two types of plants by local ethnic in the Doulu village, Karo District, North Sumatra.

- a. Celery (*Apium graveolens*) with leek (*Allium porum*)
- b. Celery (*Apium graveolens*) with tomato (*Solanum lycopersicum*)
- c. Tomato (*Solanum lycopersicum*) with cabbage (*Brassica* sp.)
- d. Chili (*Capsicum annuum*) with lettuce (*Lactuca sativa*)
- e. Cabbage (*Brassica* sp.) with leek (*Allium porum*)
- f. Lettuce (*Lactuca sativa*) with leek (*Allium porum*)

When analyzed in the further selection of plants in intercropping by farmers conducted concerning morphology and structure of the leaves canopy. The plants that intercropping are the plants with leaves relatively distinct morphology are the plant with linearis or small-leaves. For example, cabbage (*Brassica* sp.) has broad leaves intercropping with leek (*Allium porum*) which has leaves that linearis. Those are alleged the consideration by the farmers in the efficiency of absorption of sunlight to support the growth and production. The efficiency in the absorption of sunlight, some of the respondents to reduced of leaves especially the mature leaves so that aerasi can be optimal and ovoid fungal attack. Fungal attack characterized by the occurrence of decay in the roots which followed withered leaves and death of plants.

Intercropping can be done by planting two types of plants at the same time or by planting one plant beforehand. For example by some farmers, in the beginning of land cultivated with celery (*Apium graveolens*), and than followed by other plant (tomato/ *Solanum lycopersicum* or Chili/ *Capsicum annuum*) when the celery to be harvest. If the farmer's cultivation two types of plants from the beginning, so the farmers to choose two types of plants with different a time of harvesting. The farmers in the Doulu village was also done intercropping by the cultivation of three types of plants in a land and a time. The species are celery (*Allium porum*), tomato (*Solanum lycopersicum*) with chili (*Capsicum annuum*) (Figure 3). To maximize production of cultivating plants by farmers done regularly of time cultivation and space in intercropping.



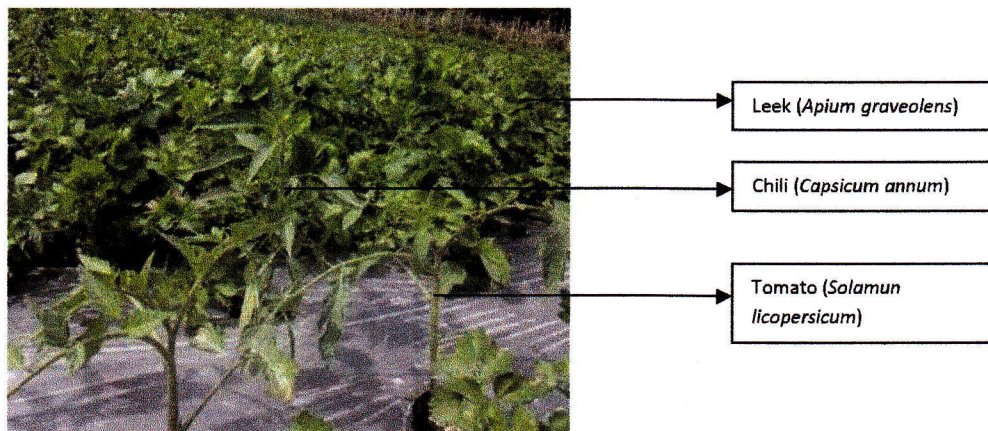


Figure 3. The pattern of intercropping by local communities in the Doulu village through the cultivation of three of plants types are celery (*Allium porum*), tomato (*Solanum lycopersicum*) with chili (*Capsicum annum*) a time.

The plants that are intercropping by farmers in Doulu village are annual plants with at harvest about 3-4 months. Those resulted that farmers can earn income in each month. The plant that intercropping have different in height. For example: the height of celery, chili, and tomato are 25 cm, 100 cm, and 150 cm respectively. Those showed that the farmers in the Doulu village have understood of characters and growth of plants which they choose in intercropping. Intercropping used three types of plants in this research has not been found in the other local communities.

4. Discussion

The land tenure patterns through intercropping are the local knowledge that developed the vary of groups ethnic in Indonesia and the other countries for efficiency in land use and to increase agricultural production. In this study, the farmers in the Doulu village used the land through rotating between wetlands and drylands. The wetland used to cultivate of paddy (*Oryza sativa*). The farmers only used dryland that management with intercropping. The farmers of done intercropping in the flat land while the land is sloping relatively undisturbed. It shows that local wisdom in preserving nature and the environment. Sumantri and Sukiyono [8] stated that in essence, farmers have had local knowledge of the ecology, agriculture, forestry has been formed hereditary and evolve over time. Local knowledge to mangement of land be affected by cultural, social, economic, political and developmental fulfillment [9,10] and market demand.

The plants types are cultivated by farmers in the land are celery, leek, tomatoes, chili, cabbage, and lettuce. Cultivation of vegetable (annual plants) by local communities in highland is found in the local communities in Bengkulu Rejang Lebong [8]. Selection of plant is cultivated by farmers dependent on the climate and topography. Stirlin et al. [7] reported that the local communities in Sri Lanka cultivating of rubber (*Hevea brasiliensis*) in lowland area but no in highland.

Intercropping patterns were found in the Doulu village are varies with cultivate by 2-3 types plants in a field. The farmers have done intercropping with two types plants more than two types plants. The intercropping pattern were found which used three plants types in this research different from in other communities. The intercropping were used two plant types are sugarcane (*Sacharrum officinarum*) and soybean (*Glycine max*) [3], corn (*Zea mays*) with peanuts (*Arachis hypogea*) [2,5], upland rice (*Oryza sativa*), corn [4]. The plant in intercropping are competition or complementary (Wibomo 2009). Competition of plants in intercropping includes nutrients, water, oxygen and sunlight, which caused inhibition the growth of plants, whereas the caused growing and produvties of plants better than monocultures. In this study, respondents said that the productivity of land through intercropping greater than monocultures. Rifai et al. [3] found that the Value of Land Equality (VLE) through intercropping by sugar cane and soya greater than monocultures.





The pattern of intercropping by in this study is various in early planting. The some of the farmer cultivated simultaneously of the all of the plant, but some of them cultivated a gradually for the second and the third of plants types. Nurma [2] founded that the delay of cultivated of corn (*Zea mays*) in the land with early planting with peanuts (*Arachis hypogea*) resulted in the difference in intensity of light received in peanut, which effects to growth and yield of peanut (*Arachis hypogea*), and vice verse.

5. Conclusion

1. Local communities in the Doulu village done intercropping to the efficiency of land and to improve productivity.
2. Intercropping by local communities done through cultivating 2-3 types of plants, such as: celery (*Apium graveolens*), leek (*Allium porum*), chili (*Capsicum annuum*), cabbage (*Brassica* sp.), and tomato (*Solanum lycopersicum*).
3. The main factors considered by the farmers in the selection of plants intercropping are age, canopy, and productivity of plants.

6. Acknowledgment

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