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THE LOCAL WISDOM BY FARMER IN EAST JAVA: UTILIZATION OF CULTIVATED PLANT IN INTERCROPPING SYSTEM

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Abstrak: *Various forms of farming patterns was exist today. The objective of this study was to determine the pattern intercropping systems done by a farmer based on the local wisdom in East Java. The data was obtained from the survey in several districts of East Java province such as Bangkalan, Sampang, Pamekasan, Sumenep, Lamongan, Kediri, Sidoarjo, Gresik, and Probolinggo district. The data was grouped according to the combined of plant species. The results showed the farmers cultivated amount of 28 plant species with 80 combinations of model cropping systems. Furthermore, the data give the information amount of 31 percent (25 combination) was similar combination among farmers. On the other hand, the amount of 69 percent (55 combination) was different among farmers.*

Kata Kunci: intercropping systems, model combination, local wisdom

INTRODUCTION

The factor of cultivation divide into the physical and non-physical factors. Physical factors in crop cultivation is the climate and soil, rainfall, solar radiation, air temperature, wind and humidity. Non-physical factors specifically related to humans. Humans as actors have ties to cultural traditions, economic circumstances, political and religious. Factors include the dominant role of the public conduct of social, economic, and political policies such as tradition and religion or belief, price and ease of transportation and the existence of marketing channels, price stability and the availability of capital and credit.

Intercropping can increase the kinds and number of broad unity of production per unit time, can reduce the risk of crop failures, increasing the productivity of land use, the time and resources available during the growing season, resulting in a total output in the sense of high economic value (Gascho, 2001). David *et al*. (2002), crop rotation has an impact on the development of a complex of pests, crop yields and economics. Soil cultivation and crop rotation are the two management in improving the physical characteristics of the soil (Katsvairo *et al*., 2002). While Popp (2002), was reported to increase the yield of soybean production needed a good watering, one of them by utilizing rainwater. The objectives of this study was to make clear the cropping patterns by farmer in East Java at the end of the rainy season.

MATERIALS AND METHODS

Methodology for the Surveys

In 2013, the surveys were carried out in rural area of Bangkalan, Sampang, Pamekasan, Sumenep, Lamongan, Kediri, Sidoarjo, Gresik, and Probolinggo districts. The surveys were carried out at the end of the rainy season which corresponds during 2013 year. The data was collect from 150 farmers for the respondents. Based on the method of Kubota *et al.* (2002) and all the useful plants observed were classified into eight categories according to the purpose of utilization, i.e. fruit trees, vegetables, starchy crops, spice plants, medicinal plants, industrial plants, ornamental plants, and plants for miscellaneous uses, including trees for building, firewood, etc. Moreover, we collected information about the kind of plant cultivated by the owners of fields. In addition, the number of plants combination grown in the fields was counted and compared among farmers.

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RESULTS AND DISCUSSION

Climate is an important role in determining the types and cultivars of plants. Phenology and rate of development of a plant depends on climatic factors such as temperature, day length and water supplies (Setiawan, 2009). From this research indigenous plant varieties intercropped obtained 28 kinds of plants that are cultivated by farmers as shown in Table 1. Maize, cassava and peanuts are the majority of the plants chosen by the farmer. Maize and cassava is a crop that is used to meet the daily needs of farmers and the rest sold.

Table 1: Number of Useful Plant Species Observed in 9 District

No	Species	Number of farmer
	Fruit Trees	
1	*Carica papaya* L.	3
2	*Cocos nucifera* L.	3
3	*Mangifera indica*	8
4	*Musa sp.*	21
	Total no. of species	4
	Total no. of farmer	35
	Vegetables	
1	*Arachis hypogaea* L.	78
2	*Capsicum frutescens*	23
3	*Glycine max*, Linn.(Merrill.)	8
4	*Lablab purporeus*	1
5	*Leucaena leucocephala*	2
6	*Moringa oleifera* Lamk.	1
7	*Phaseolus radiatus* L.	9
8	*Sesamum indicum* L.	1
9	*Sesbania grandiflora* Pers.	7
10	*Solanum melongena* L.	9
11	*Vigna umbellate*	2
12	*Vigna sinensis* L.	24
	Total no. of species	12
	Total no. of farmer	165
	Starchy crops	
1	*Canna edulis* Ker.	2
2	*Colocasia esculenta* schott.	14
3	*Dioscorea alata* L.	1
4	*Ipomoea batatas*	11
5	*Manihot esculenta* Crantz.	48
6	*Oryza sativa* L.	7
7	*Zea mays* L.	80
	Total no. of species	7
	Total no. of farmer	163
	Medicinal plants	
1	*Curcuma domestica* Val.	3
2	*Piper retrofractum* Vahl	3
3	*Zingiber cassummunar* roxb.	1
	Total no. of species	3
	Total no. of farmer	7
	Plants for miscellaneous uses	
1	*Borassus flabellifer*	1
2	*Tectona grandis* L.	6
	Total no. of species	2
	Total no. of farmer	7
	Total	**377**

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Table 2: Models of Plant Combinations that Have Similarities Between Regions / Farmers With Other Farmers As Many Of The 80 Models

No. Model	The plants combination used by farmers		Number of farmer
1	*Arachis hypogaea* L. - *Capsicum frutescens*	Vegetables – vegetables	2
2	*Arachis hypogaea* L. - *Phaseolus radiatus* L.	Vegetables – vegetables	4
3	*Capsicum frutescens* - *Vigna sinensis* L.	Starchy crops – vegetables	2
4	*Colocasia esculenta* schott. - *Arachis hypogaea* L.	Starchy crops – vegetables	2
5	*Ipomoea batatas* - *Zea mays* - *Arachis hypogaea* L.	Starchy crops - starchy crops - vegetable	2
6	*Manihot esculenta* Crantz. - *Arachis hypogaea* L.	Starchy crops – vegetables	4
7	*Manihot esculenta* - *Arachis hypogaea* - *Phaseolus radiatus* - *Sesbania grandiflora*	Starchy crops – veg. – veg. - vegetables	2
8	*Manihot esculenta* Crantz. - *Arachis hypogaea* L. - *Vigna sinensis* L.	Starchy crops - vegetables - vegetables	3
9	*Manihot esculenta* Crantz. - *Capsicum frutescens*	Starchy crops – vegetables	2
10	*Manihot esculenta* Crantz. - *Colocasia esculenta* schott.	Starchy crops - starchy crops	2
11	*Manihot esculenta* Crantz. - *Colocasia esculenta* schott. - *Arachis hypogaea* L.	Starchy crops - starchy crops - vegetables	3
12	*Manihot esculenta* Crantz. - *Ipomoea batatas*	Starchy crops - starchy crops	3
13	*Manihot esculenta* Crantz. - *Vigna sinensis* L.	Starchy crops – vegetables	3
14	*Manihot esculenta* Crantz. - *Zea mays*	Starchy crops - starchy crops	4
15	*Manihot esculenta* Crantz. - *Zea mays* - *Arachis hypogaea* L.	Starchy crops - starchy crops - vegetable	4
16	*Musa sp.* - *Tectona grandis* L.	Fruit - miscellaneous uses	2
17	*Oryza sativa* L. - *Zea mays*	Starchy crops - starchy crops	2
18	*Oryza sativa L.* - *Zea mays* - *Mangifera indica*	Starchy crops - starchy crops - fruits	2
19	*Zea mays* - *Arachis hypogaea* L.	Starchy crops – vegetable	27
20	*Zea mays* - *Arachis hypogaea* L. - *Phaseolus radiatus* L.	Starchy crops - vegetables - vegetables	2
21	*Zea mays* - *Arachis hypogaea* L. - *Vigna sinensis* L.	Starchy crops - vegetables - vegetables	5
22	*Zea mays* - *Capsicum frutescens*	Starchy crops – vegetables	3

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23	*Zea mays* - *Glycine max*, Linn.(Merrill.)	Starchy crops – vegetables	5
24	*Zea mays* - *Vigna sinensis* L.	Starchy crops – vegetables	2
25	*Zea mays* - *Vigna umbellate*	Starchy crops – vegetables	2
1	*Arachis hypogaea* L. - *Mangifera indica*	Vegetables – fruits	1
2	*Arachis hypogaea* L. - *Phaseolus radiatus* L.	Vegetables – vegetables	1
3	*Arachis hypogaea* L. - *Sesbania grandiflora* Pers. - *Mangifera indica* - *Musa sp.*	Vegetables - vegetables - fruits - fruits	1
4	*Arachis hypogaea* L. - *Solanum melongena* L. - *Musa sp.* - *Tectona grandis*	Veg. – veg. - fruits - miscellaneous uses	1
5	*Arachis hypogaea* L. - *Vigna sinensis* L. - *Musa sp.*	Vegetables - vegetables – fruits	1
6	*Canna edulis* Ker. - *Manihot esculenta* Crantz. - *Tectona grandis*	Starchy - starchy - miscellaneous uses	1
7	*Canna edulis* Ker. - *Tectona grandis*	Starchy crops - miscellaneous uses	1
8	*Capsicum frutescens* - *Solanum melongena* L.	Vegetables – vegetables	1
9	*Capsicum frutescens* - *Solanum melongena* L. - *Musa sp.*	Vegetables - vegetables – fruits	1
10	*Carica papaya* L. - *Musa sp.* - *Sesbania grandiflora* Pers.	Fruits - fruits – vegetables	1
11	*Colocasia esculenta* S. - *Ipomoea batatas*	Starchy crops - starchy crops	1
12	*Colocasia esculenta* S. - *Dioscorea alata* L.	Starchy crops - starchy crops	1
13	*Colocasia esculenta* S. - *Dioscorea alata L.* - *Manihot esculenta* Crantz.	Starchy crops - starchy crops - starchy crops	1
14	*Colocasia esculenta* S. - *Dioscorea alata* L. - *Manihot esculenta* Crantz. - *Musa sp.*	Starchy - starchy - starchy - fruits	1
15	*Colocasia esculenta* - *Manihot esculenta* - *Arachis hypogaea* - *Capsicum frutescens*	Starchy - starchy - vegetables - vegetables	1
16	*Colocasia esculenta* S. - *Manihot esculenta* Crantz. - *Capsicum frutescens*	Starchy crops - starchy crops - vegetables	1
17	*Colocasia esculenta* S. - *Manihot esculenta* Crantz. - *Musa sp.*	Starchy crops - starchy crops - fruits	1
18	*Colocasia esculenta – M. esculenta – C. nucifera* - *Musa sp.* - *Leucaena leucocephala*	Starchy - starchy - fruits - fruits - vegetables	1
19	*Colocasia esculenta* schott. - *Solanum melongena* L.	Starchy crops – vegetables	1
20	*Colocasia esculenta* schott. - *Zea mays*	Starchy crops - starchy crops	1
21	*Dioscorea alata* - *Manihot esculenta* - *Glycine max* - *Capsicum frutescens*	Starchy - starchy - vegetables - vegetables	1
22	*Ipomoea batatas* - *Arachis hypogaea* L. - *Capsicum frutescens*	Starchy crops - vegetables - vegetables	1

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23	*Ipomoea batatas* - *Manihot esculenta* Crantz. - *Capsicum frutescens*	Starchy crops - starchy crops - vegetables	1
24	*Ipomoea batatas* - *Solanum melongena* L.	Starchy crops – vegetables	1
25	*Ipomoea batatas* - *Vigna sinensis* L.	Starchy crops – vegetables	1
26	*Manihot esculenta* Crantz. - *Arachis hypogaea* L. - *Capsicum frutescens*	Vegetables - vegetables - vegetables	1
27	*Manihot esculenta* Crantz. - *Capsicum frutescens* - *Musa sp.*	Starchy crops - vegetables - fruits	1
28	*Manihot esculenta* Crantz. - *Carica papaya.* - *Musa sp.* - *Sesbania grandiflora*	Starchy crops - fruits - fruits - vegetables	1
29	*Manihot esculenta* Crantz. - *Curcuma domestica* Val	Starchy crops - medicinal plants	1
30	*Manihot esculenta* - *Musa sp.* - *Curcuma domestica* - *Leucaena leucocephala*	Starchy - fruits - medicinal plants - vegetables	1
31	*Manihot esculenta* Crantz. - *Sesbania grandiflora* Pers.	Starchy crops – vegetables	1
32	*Manihot esculenta* Crantz. - *Zea mays* - *Arachis hypogaea* L. - *Capsicum frutescens*	Starchy - starchy - vegetables - vegetables	1
33	*Manihot esculenta* Crantz. - *Zea mays* - *Arachis hypogaea* L. - *Musa sp.*	Starchy - starchy - vegetables - fruits	1
34	*Manihot esculenta* Crantz. - *Zea mays* - *Arachis hypogaea* L. - *Vigna sinensis* L.	Starchy - starchy - vegetables - vegetables	1
35	*Manihot esculenta* Crantz. - *Zea mays* - *Capsicum frutescens*	Starchy crops - starchy crops - vegetables	1
36	*Manihot esculenta* Crantz. - *Zea mays* - *Capsicum frutescens* - *Solanum melongena*	Starchy - starchy - vegetables - vegetables	1
37	*Manihot esculenta* - *Zea mays* - *Capsicum frutescens* - *Solanum melongena* - *Musa sp.*	Starchy - starchy – veg. – veg. - fruits	1
38	*Moringa oleifera* - *Solanum sp.* - *C. papaya.* - *C. nucifera* - *Musa sp.* - *P. retrofractum*	Veg. - veg. - fruits - fruits - fruits - medicinal	1
39	*Musa sp.* - *Mangifera indica*	Fruits - fruits	1
40	*Musa sp.* - *Sesbania grandiflora* Pers.	Fruits - vegetables	1
41	*Oryza sativa* L. - *Zea mays* - *Arachis hypogaea* L.	Starchy crops - starchy crops - vegetables	1
42	*Oryza sativa* L. - *Zea mays* - *Arachis hypogaea* L. - *Musa sp.*	Starchy - starchy - vegetables - fruits	1
43	*Oryza sativa* L. - *Zea mays* - *Arachis hypogaea* L. - *Solanum melongena* L.	Starchy - starchy - vegetables - vegetables	1
44	*Oryza sativa* L. - *Zea mays* - *Capsicum frutescens* - *Glycine max,* Linn.(Merrill.)	Starchy - starchy - vegetables - vegetables	1
45	*Phaseolus radiatus* L. - *Glycine max,* Linn.(Merrill.) - *Vigna sinensis* L.	Vegetables - vegetables - vegetables	1
46	*Phaseolus radiatus* L. - *Piper retrofractum* vahl - *Borassus flabellifer*	Vegetables - medicinal - miscellaneous uses	1
47	*Zea mays* - *Arachis hypogaea* L. - *Leucaena leucocephala* - *Vigna sinensis* L.	Starchy - vegetables - vegetables - vegetables	1
48	*Zea mays* - *Arachis hypogaea* L. - *Mangifera indica* - *Musa sp.*	Starchy crops - vegetables - fruits - fruits	1

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49	*Zea mays* - *Arachis hypogaea* L. - *Vigna sinensis* L. - *Musa sp.*	Starchy crops - vegetables - vegetables - fruits	1
50	*Zea mays* - *Capsicum frutescens* - *Mangifera indica* - *Musa sp.* - *Curcuma domestica*	Starchy – veg. - fruits - fruits - medicinal	1
51	*Zea mays* - *Phaseolus radiatus* L.	Starchy crops – vegetables	1
52	*Zea mays* - *Phaseolus radiatus L.* - *Glycine max,* Linn. (Merrill.)	Starchy crops - vegetables - vegetables	1
53	*Zea mays* - *Piper retrofractum* vahl	Starchy crops - medicinal plants	1
54	*Zea mays* - *Sesamum indicum* L.	Starchy crops – vegetables	1
55	*Zea mays* - *Zingiber cassummunar* roxb.	Starchy crops - medicinal plants	1

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There are 80 model of plant (species) combinations cultivated by farmers as shown in Table 2. The number of 25 model of plant combinations have similarities among farmer (31 %), whereas 55 (69 %) model of plant combinations was different among farmers.

Based on the number of plants combinations used by owner of fields, this research give information that the farmer used 2, 3, 4, 5, and 6 plant combinations, respectively around 61, 24, 12, 2, and 1 % as in Figure 1.

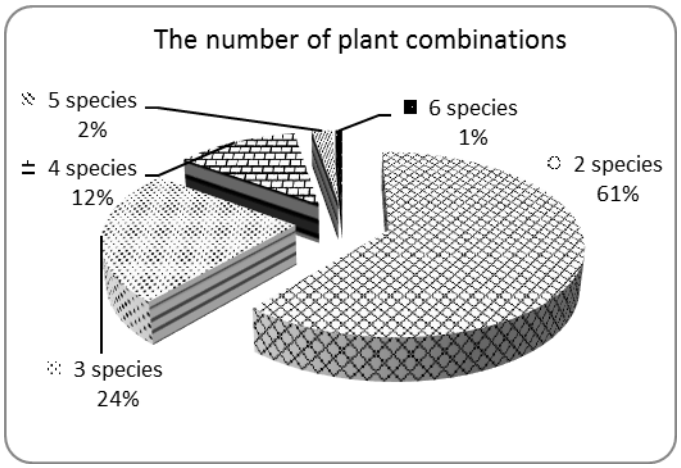

Figure 1. The Number of Plant Combinations Was Cultivated By Farmers

Intercropping can successfully and efficiently if have the principle such as:

a. Two or more plants not have the same a period of growth.
b. When intercropping plants have nearly the same age, preferably of different growth phases
c. There are differences in the need for environmental factors such as water, moisture, light and nutrients
d. The plants have different canopy architecture and high real crops
e. Plants have different roots, good nature, extent and depth of roots
f. Plants have no effect allelopathy.

The combination of corn and peanuts was majority cultivated by farmers during the end of the rainy season. In general, farmers make crop intercropping combinations between food crops such as corn, taro, and cassava in combination with other crops. Dalrymple (1971) reported that the occurrence of intercropping systems throughout the tropics, and concluded that intercropping is widespread. Estimates that 98% of nuts, legumes problem is most important that exist in Africa, combined with the growth of other plants (Arnon, 1972). Norman's review in northern Nigeria (1974) reported a mixed cropping pattern contained 83% of all existing plants on land. In Colombia 90% of the bean crop grown by merging with corn, potatoes, and other crops. While in Guatemala 73% of the bean production comes from cropping. Frances and Flor (1975) estimates that in the tropics of Latin America, 60% of the corn crop is the result of merging with another. Furthermore, in Asia and China, usually, all planned land planted with rice once a year and after the rice is harvested, the second crop soybeans, chickpeas, beans or corn. In this situation the sequence cropping pattern of sequential combination, combined, and cropping, can be used with good environment. Intercropping in Asia, frequently planted rice roughly every rainy season. During the summer of land may be in the plan back to the rice.

But it is often used to plant beans. Intercropping is an attempt to grow some plants on land and the same time, which is arranged in rows of plants. Planting in this way can be done in two or more types of plants that are relatively the same age, for example, corn and peanuts. To be able to execute well Cropping patterns to note some of the environmental factors that have an influence among the availability of water, soil, sunlight and pests and diseases. Smeltekop (2002) suggests the use of peanut plants in intercropping can contribute N to the soil.

Determination of the type of plants that will be intercropped and planting time should be adjusted to the existing availability of water during growth. It is intended to obtain optimal growth and production. Soil

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fertility is absolutely necessary, it is intended to avoid competition (the absorption of nutrients and water) on a plot of land between crops. Cropping pattern should be selected and combined between plants that have relatively deep roots and plants that have relatively shallow roots. The distribution of sunlight is important, it aims to avoid competition between plants in sunlight, high and wide to note between the plant canopy. Canopy height and width between intercropped plants that will affect the acceptance of solar light, will further affect the synthesis (glucose) and will ultimately affect the overall results.

Cropping pattern is an investment business on a parcel of land with a set pattern. Cropping pattern is defined as a composition layout and sort order for the plants on a plot of land for a certain period, including tillage and fallow (Beets, 1982). Cropping patterns contained in the principles that must be considered, namely: intercropped plants should have the age or period of growth are not the same, have different needs against environmental factors such as water, moisture, light and nutrients influence plant allelopathy. The success of intercropping system is determined by several factors, including interspecific and intraspecific interactions form a combination that allows the plant. In intercropping systems also generally more profitable than planting in monoculture as land productivity is also higher, diverse types of commodities produced, suggestions efficient in the use of production and the risk of failure can be minimized. In addition to the above benefits of intercropping systems can also reduce erosion, even in this way are also successful in maintaining soil fertility. Appropriate time in the planting of this commodity is after the end of the rainy season. Because if this commodity planted at the beginning of the rainy season, so many seeds that will rot and cause death. The purpose of the farmers here use the cropping pattern of intercropping system are:

a) Increase the kind and amount of production per unit area per unit time.
b) Reduce the risk of crop failure
c) Increasing the productivity of land use, the time and resources available during the growing season.
d) Obtain the total output in the sense of high economic value.

The survey results and interviews with farmers about the reasons farmers do intercropping on farms owned are as follows:

1. Just for the consumer to self / family. Consumption requirements on small farmers only slightly. Only to meet the needs of the family. Thus, in the cultivation of plants in a single land use intercropping system.
2. None collectors / distributors. Distributors in the countryside only a few, if any collectors only buy at a cheap price.
3. Narrow land. Narrow land causing farmers to plant with intercropping system. Multiple cropping can maximize the production of land owned by farmers.
4. Labor Fund. In managing land many farmers rely on the family to manage land owned. This is also due to the cost of the farmer-owned limited. So the planting system with intercropping systems become an alternative solution, so that the land owned produce multiple crops.
5. Knowledge on Cultivation. Knowledge of plant cultivation for farmers is still lacking. Knowledge possessed only the result of heredity / inheritance. So unwittingly intercropping growers often done to follow the ancestors. In fact, such activity is a form of local knowledge.

In almost all dual culture system developed by smallholders, productivity levels can be harvested per unit area is higher than the cultivation of a single plant with the same level of management. Advantages can harvest ranged from 20-60% (Frances 1975). This difference as a result of various factors, such as higher growth rates, decrease losses caused by weeds, insects and diseases as well as more efficient utilization of the water resources, sunlight and nutrients available. If some of the crops grown at the same time, the failure of one of the plants can be compensated by other plants (either as actual yields or in terms of the value of money). This reduces the risk of farming. To increase land productivity and income of farmers in dry land cropping can be done through intercropping, crop intercropped as on dry land to maintain soil moisture and water levels and reduce erosion and improve soil fertility (Beets, 1982).

Intercropping is one form of agricultural intensification programs appropriate alternative to double agricultural output in areas that are less productive. The advantage is obtained in addition to harvest more than once a year, also maintain soil fertility by returning organic matter that much and the soil by the plant canopy closure. Intercropping in cropping systems, in order to obtain the maximum results intercropped plants should be chosen such that it is able to utilize the space and time efficient as possible and can reduce the influence of the smallest competitive. Furthermore Harrera (1974) explains that the type of plants used in intercropping should have different growth, even when possible can be complementary. Intercropping

maize plants can be done with upland rice, other crops or vegetables are done with a purpose; (1) diversification of the use of food, (2) reduce the risk of crop failure, and (3) increasing the cropping intensity (Beets, 1982).

Dual agricultural system is very suitable for our farmers with small land in the tropics, so as to maximize production with low external inputs while minimizing risk and preserving natural resources. Besides other advantages of this system: (a) reducing soil erosion or loss of soil though, (b) improve water management in agricultural soils, including increasing the supply (infiltration) of water into the soil so that water reserves for plant growth will be available, (c) to fertilize and improve soil structure, (d) enhance the efficiency of land so that the farmers' income will increase as well, (e) is able to save on labor, (f) avoid seasonal unemployment because arable land continuously, (g) tillage does not need to be done repeatedly, (h) to reduce the population of pests and plant diseases, and (i) enriching the nutrient content between nitrogen and other organic materials (Beets, 1982).

Another double cropping system is a system that shifts overlap, which is how to grow crops by using 2 or more types of plants in a field with the timing. The second planting is done after the first flowering plants. So that the plant will be able to live together in a relatively long time and the closure of land can be protected during the rainy season (Beets, 1982).

Soil and Cropping Pattern Systems. Terms ground for intercropping is basically the same as the other forms. Of intensive crop production, when the soil is not fertile, alkalinity combine plants with different root believed to have decent production. When a single plant gives only a small yield due to lack of nutrients into the main street in obtaining different species.

In the arrangement cropping patterns, population growth and the strength of the intensity of the cropping pattern is often determining soil fertility. The high fertility of the soil, plants that float or cropping patterns that require the use of the environment. When natural fertility and low soil fertility unavailability of planting pattern sequence is not as expected. But cropping can be profitable. The next situation is usually set up a rain forest area in the tropics, in the wet equatorial regions, especially where the soil is often very arid relative to release. Intercropping in this area can also be beneficial, in addition to the ground for the better and will protect the soil from erosion and damage due to rain. Where in the humid tropics into fertile soil, and the order of the combined system of cropping patterns have a high earning potential (Beets, 1982).

CONCLUSION

From the research, a variety of indigenous plants in East Java intercropping obtained 28 kinds of plants that are cultivated by farmers. There are 80 combinations of the model plant, where there are a number of similarities between the plant model of the combination of local farmers / growers to each other in the amount of 31% (25 models). While the remaining 69% (55 models) Model plant combinations between regions / farmers with other farmers a different one.

Based on the number of combinations of plants used in the cropping pattern of intercropping systems in East Java there are: 61% of farmers grow two crops combined; 24% of farmers grow three crops combined; 12% of farmers to plant crops 4 combinations; 2 5% of farmers grow crop combinations; and the remaining 1% of farmers seeking a combination of 6 plants. Maize, cassava and peanuts are the majority of the plants chosen by the farmer.

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