

Agricultural Practices in East Java, especially Madura Island — Actual Situation of Crop Production — *

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Introduction

During the period from June to July in 1981, the writer was sent to Indonesia for research on agricultural practices under the project, designated "Ecological Biology and the Promotion of Tropical Primary Industry". While the observation was made not only in East Java but also in Middle Java and Bali Island for the comparative discussion, the results obtained in East Java, especially in Madura Island, are briefly reported in this paper. Twenty-nine strains of cultivated rice, *Oryza sativa* L., distributed in Madura Island and in other prefectures of East Java were collected, and studied morphologically. Their results may be reported in a separate article.

The main purpose of this project was to observe the actual production systems under the humid tropics, and then, to consider how to modify or maintain them, and introduce recent technological advancement, if necessary. Several research reports on the agricultural practices in Indonesia have been published⁶⁻⁹⁾. However, no distinct record has been reported on these items in East Java, especially in Madura Island. On the basis of these considerations, the present survey was made focusing crop plants. In this report, the agricultural practices were denoted as several points, *i.e.*, kind of crops, kind of strains, cropping systems, multi-cropping systems, their alternation according to period, etc.

Experimental Methods

Methodology constituted of 2 parts. For the analyses on the kinds of crops, their alternation product and characteristics, statistical reports¹⁾ published by the governments concerned were used. In this sense, the products of the respective crop kinds were used for key columns for locality speciations, alternations and their backgrounds. In detail, the

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following parts are mentioned: i) share of individual products in the respective prefectures to the whole of East Java (Fig. 2), ii) share of individual crops in the respective prefectures (Fig. 3), iii) share of individual products in 4 districts to the whole of Madura (Fig. 4), iv) share of individual crops in 4 districts (Fig. 5), v) yearly fluctuations of individual crops (Figs. 6–8), vi) agricultural program for a year (Figs. 9–10).

Though coconut palm is one of the most important crop kinds in these areas, it was omitted in chapter 1, because its productivity was detected, in general, to be a constant and steady feature.

For the discussion of kinds of strains, cropping system, multi-cropping system, relations between crop plants and other organisms, significance of the respective ones, hearing and observations were done by the government officers and farmers, and were adopted in this report. These items were arranged as follows: i) climatic conditions, ii) kinds of crops, iii) cropping systems during a year, iv) alternating cropping and multi-cropping systems, v) cover crops, vi) reclamations, vii) and other related information.

Results and Discussion

The results obtained are reported in 2 parts.

PART I. Statistical analyses

East Java Province is constituted by 7 prefectures, *i.e.*, Surabaya, Bojonegoro, Madiun, Kediri, Malang, Besuki and Madura. Madura Prefecture is divided into 4 districts, namely, Bangkalan, Sampang, Pamekasan and Sumenep districts (Fig. 1). For

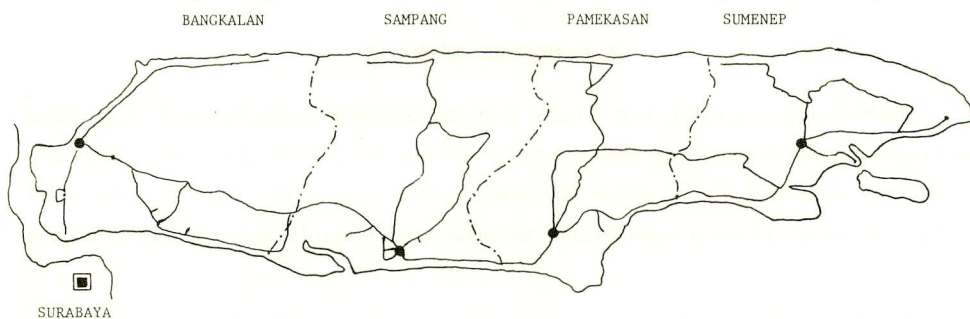


Fig. 1. Map showing constitution of Madura Island. Solid line; route of observations, dotted line; boundary of districts, filled circle; main town.

this chapter, 12 crop kinds were mainly adopted for statistical analyses, *i.e.*, *PADI SAWAH* (translated in this paper to English as paddy rice, and so forth), *PADI RENDENGAN* (paddy rice in wet season), *PADI GADU* (paddy rice in dry season), *PADI GOGO* (upland rice), *PADI GOGORANCAH* (direct sowing culture paddy rice on well-drained paddy field, abbreviated as direct sowing rice in this paper), *JAGUNG* (maize), *UBI KAYU* (cassava), *UBI JALAR* (sweet potato), *KACANG TANAH* (peanut), *KEDELE* (soybean), *KACANG HIJAU* (*Phaseolus aureus* MUNG, gram) and *SORGHUM* (sorghum).

Basing on the data obtained from these statistics and hearing, the following facts were ascertained to some extent.

1. Share of individual products in the respective prefectures

The products of 12 crop kinds mentioned above in the respective prefectures to the whole of East Java in 1980 were analysed, and are shown in Fig. 2. In this figure, for example, the yield of paddy rice in Madura (=225,926 ton through a year) was illustrated as 3.30% for the total products of East Java (=6,854,430 ton --- 100.00%).

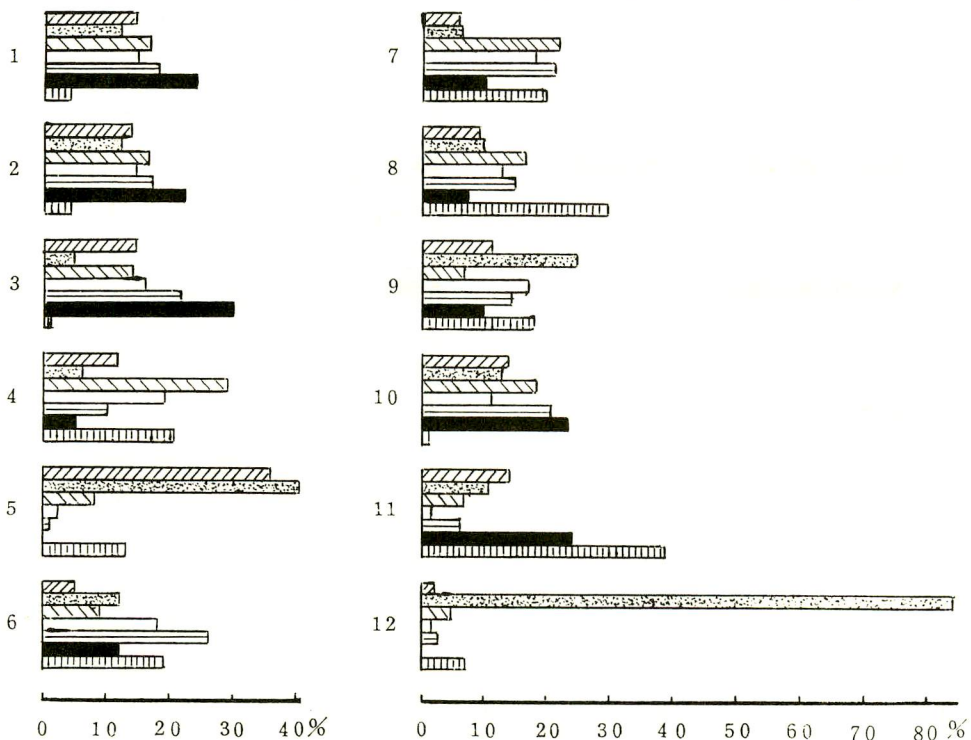


Fig. 2. Shares of the 12 crops to the whole East Java. 1; paddy rice, 2; paddy rice in wet season, 3; paddy rice in dry season, 4; upland rice, 5; direct sowing culture of paddy rice on well-drained paddy field, 6; maize, 7; cassava, 8; sweet potato, 9; peanut, 10; soybean, 11; gram, 12; sorghum.

Prefectures: Surabaya, Bojonegoro, Madiun, Kediri, Malang, Besuki, Madura.

In Madura, the largest portion (38.91%) was obtained in gram, followed by sweet potato (29.95%) and upland rice (20.31%). The smallest portion (0.50%) was noted in paddy rice in dry season, followed by soybean (0.67%) and paddy rice (3.30%). It was noted that the values were peculiarly large and small for gram and sweet potato, paddy rice in dry season and soybean, respectively. These tendencies meant that traditional agricultural systems were still maintained and practised in Madura Island. Especially, a few areas were adopted for paddy rice in dry season, which was accepted, in general, as relatively a recent system in south and southeast Asia, and was practised in the areas having developed irrigation systems. Besuki and Malang prefectures were properly looked upon as these areas.

2. Share of individual crops in the respective prefectures

In Fig. 3, production rates of 6 crops in the respective prefectures were calculated, and are shown. The production of paddy rice in Madura (=225,926 ton a year) represent 14.11% by weight of the total yield of 6 crops in Madura Island (=1,601,007 ton --- 100.00%). Other 6 crops, *i.e.*, upland rice, direct sowing rice, peanut, soybean, gram and sorghum, were surveyed but not shown in this figure, because their maximum values were ascertained to be smaller than 4%.

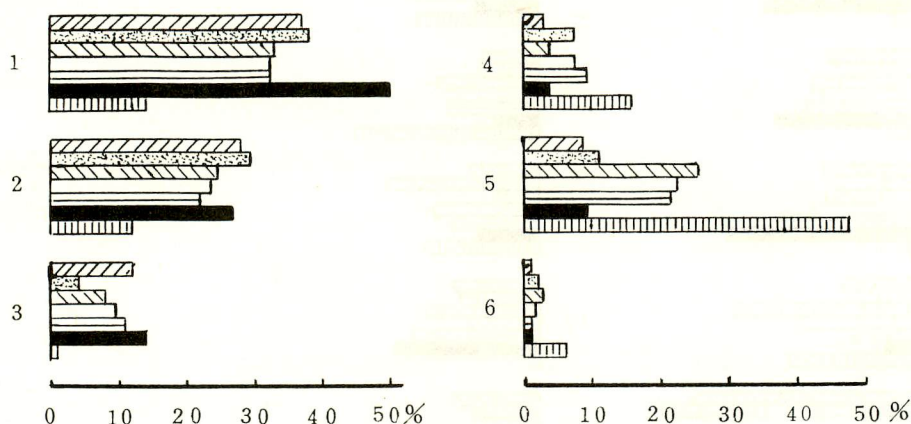


Fig. 3. Product rates of 6 crops in the individual prefectures. 1; paddy rice, 2; paddy rice in wet season, 3; paddy rice in dry season; 4; maize, 5; cassava, 6; sweet potato. Marks of prefectures are the same as that of Fig. 2.

In terms of rates occupied in the total products, cassava, maize, paddy rice and paddy rice in wet season represented 46.64%, 15.76%, 14.11% and 11.60%, respectively, in Madura. On the other hand, the same individual products listed in the same order as above made up to 19.35%, 6.78%, 34.70% and 24.19%, respectively, in all of East Java. It was noticeable that the rate of gram in this category constituted 0.82%, while in the former chapter it was found to represent 38.91% of the total product. It meant that the

total product of gram was lower in East Java, as compared to that of Madura Island. The products of the whole rice which integrated 5 patterns of rice cultivations, were found out to be as follows: Surabaya (80.61%), Bojonegoro (76.27%), Madiun (67.81%), Kediri (66.94%), Malang (65.74%), Besuki (83.40%), Madura (30.34%) and the whole of East Java (70.25%). It was also observed that the value was peculiarly small in Madura.

In conclusion, it can be said that agricultural systems in Madura were looked upon as underdeveloped and nonrepresentative of East Java.

3. Share of individual products in the 4 districts in relation to the whole of Madura

The yields of 12 crop kinds in the respective districts were analysed, and are shown in Fig. 4. For example, the products of paddy rice in Pamekasan (=26,765 ton) made up

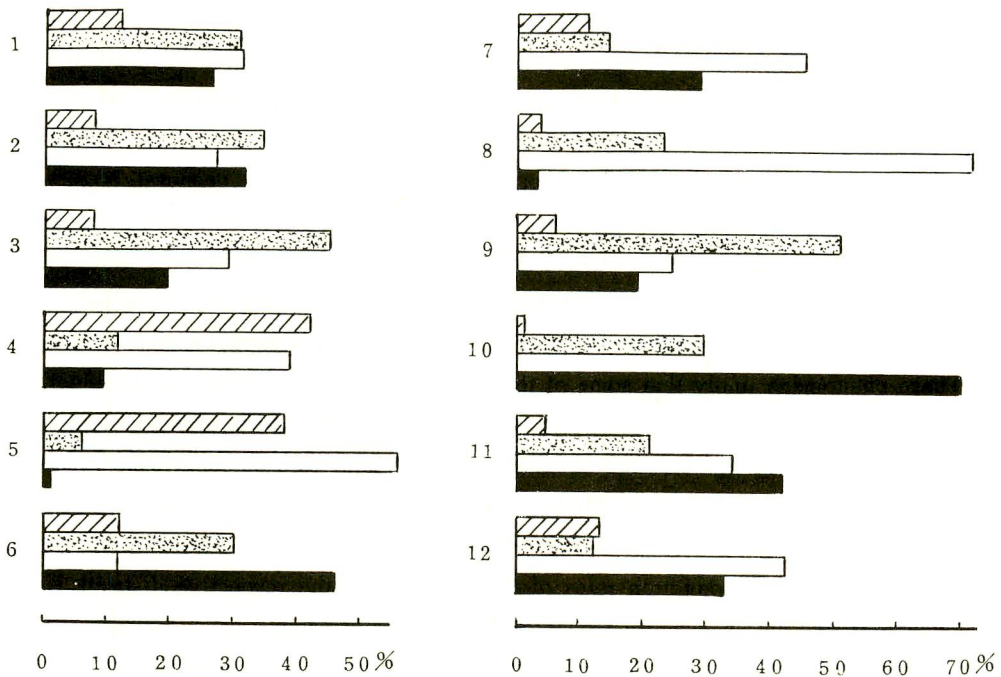


Fig. 4. Shares of the 12 crops to the whole Madura Island. Marks of crop kinds are the same as that of Fig. 2.

Districts: Pamekasan, Bangkalan, Sampang, Sumenep.

to 11.85% of the whole products of Madura Island (=225,926 ton --- 100.00%). In Pamekasan, the larger portions (40.99%, 37.64% and 12.76%) were obtained in 3 types of products (upland rice, direct sowing rice and sorghum in the same order). In Bangkalan, the larger portions (50.82%, 44.06% and 33.75%) were obtained in 3 types of products (peanut, paddy rice in dry season and paddy rice in wet season). In Sampang, the larger

portions (71.23%, 56.05% and 45.40%) were obtained in 3 types of products (sweet potato, direct sowing rice and cassava). In Sumenep, the larger portions (69.87%, 46.66% and 46.10%) were obtained in 3 types of products (soybean, paddy rice in wet season and maize).

In Pamekasan, the smaller portions (0.30%, 3.18% and 4.66%) were noted in 3 types of products (soybean, sweet potato and gram). In Bangkalan, the smaller portions (5.65%, 11.52% and 11.94%) were noted in 3 types of products (direct sowing rice, upland rice and sorghum). In Sampang, the smaller portions (0.00%, 11.78% and 24.57%) were noted in 3 types of products (soybean, maize and peanut). In Sumenep, the smaller portions (0.65%, 2.64% and 8.63%) were noted in 3 types of products (direct sowing rice, sweet potato and upland rice).

It was ascertained that 10 out of 12 types of products showed more than 40% throughout Madura only in each district, *i.e.*, paddy rice in wet season --- 46.66% in Sumenep, paddy rice in dry season --- 44.06% in Bangkalan, upland rice --- 40.99% in Pamekasan, direct sowing rice --- 56.06% in Sampang, maize --- 46.10% in Sumenep, cassava --- 45.40% in Sampang, sweet potato --- 71.23% in Sampang, peanut --- 50.82% in Bangkalan, soybean --- 69.87% in Sumenep, sorghum --- 42.84% in Sampang. Moreover, 3 of the 12 types of products showed more than 90% in the following 2 districts of Madura, *i.e.*, direct sowing rice --- 93.70% in Pamekasan and Sampang, sweet potato --- 94.19% in Bangkalan and Sampang, soybean --- 99.70% in Bangkalan and Sumenep. These phenomena imply that some of the crop kinds constituted the main production areas. On the other hand, differences according to the respective districts were relatively small in paddy rice. It meant that the production of paddy rice was looked upon as the principle agricultural system in Madura, which was the same as in the whole of Java.

4. *Share of individual crops in each of the 4 districts*

In Fig. 5, the production rates of 6 crop kinds in the respective districts were calculated, and are shown. For example, the products of paddy rice in Pamekasan (= 26,765 ton) constituted 14.57% of the total products of 6 crops in Pamekasan (= 183,689 ton --- 100.00%). Other 6 crops, *i.e.*, paddy rice in dry season, direct sowing rice, peanut, sorghum, gram and soybean, were surveyed but not shown in this figure, because these rates were found to be smaller than 3% at the maximum. In the respective districts, the main crops were recognized as follows: in Pamekasan district --- cassava (44.31%), maize (16.56%), paddy rice (14.57%); in Bangkalan district --- cassava (30.87%), maize (21.12%), paddy rice (19.07%), paddy rice in wet season (17.45%); in Sampang district --- cassava (57.47%), paddy rice (11.87%); and in Sumenep district --- cassava (43.36%), maize (23.43%), paddy rice in wet season (17.46%), paddy rice (12.22%). Percentages of total

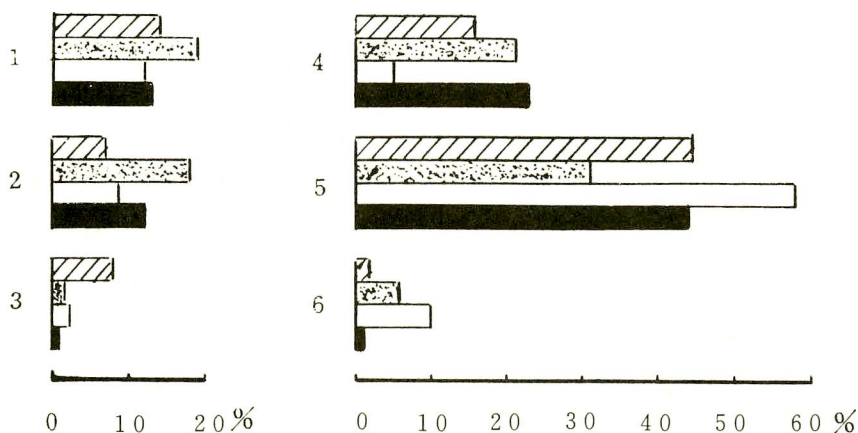


Fig. 5. Product rates of 6 crops in the individual districts. 1; paddy rice, 2; paddy rice in wet season, 3; upland rice, 4; maize, 5; cassava, 6; sweet potato. Marks of districts are the same as that of Fig. 4.

products represented by rice, which are the result of integration of five types of rice cultivation, were 36.71% in Pamekasan, 39.24% in Bangkalan, 25.97% in Sampang and 30.67% in Sumenep.

The following specific characters of agricultural systems should be noted according to district specificities: i) The first product was pointed out as cassava throughout the whole of the districts. ii) The relation between cassava and maize was looked upon as the reversed features. iii) The relation between cassava and the whole types of rice was also looked upon as the reversed features. iv) Figures show that together any 2 crops as given below constituted more than 50% in any one of the four districts of Madura, namely: 60.87% in Pamekasan (cassava and maize), 51.99% in Bangkalan (cassava and maize), 69.34% in Sampang (cassava and paddy rice) and 66.79% in Sumenep (cassava and maize). v) The maize products ranked second in 3 districts. vi) Though the rate of the total rice yield in Sampang represented the lowest weight throughout 4 districts, paddy rice ranked second in this district. In other words, the production scheme found in Sampang was regarded as differing from that of the other 3 districts.

5. Yearly fluctuation of individual crop kinds

Yearly fluctuation of the individual crop kinds is discussed here¹⁾. Firstly, annual fluctuation during 1976 to 1980 of 2 crops in 4 districts were calculated, and are shown in Fig. 6. From the figures, the following facts were ascertained: i) The products of paddy rice steadily increased in the Sampang district only. ii) The maize products showed steady increase only in Sumenep. iii) The amount of paddy rice increased and afterwards

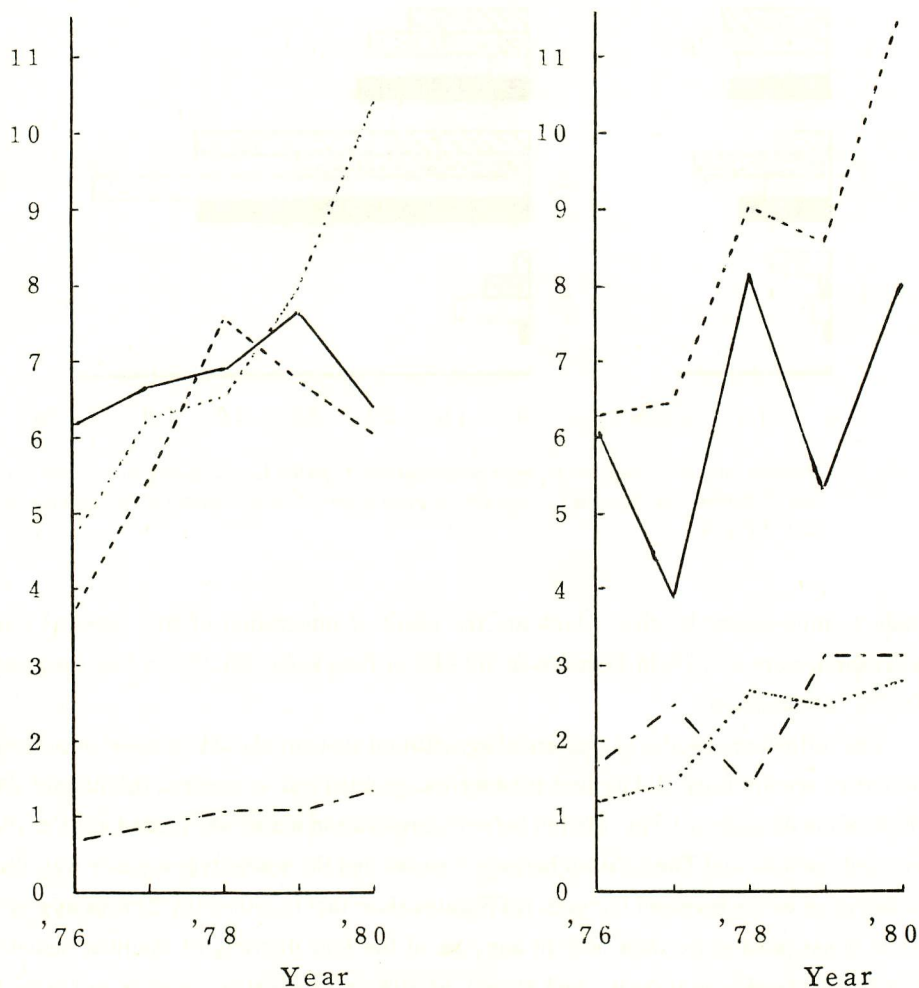


Fig. 6. Yearly fluctuations during 1976 to 1980 of 2 crop productions in the 4 districts of Madura. Left; paddy rice, right; maize. x100,000 ton.

— Bangkalan, Sampang, - - - Pamekasan, Sumenep.

decreased in Bangkalan and Sumenep. iv) The production of paddy rice in Pamekasan, and maize in Pamekasan and Sampang was shown more or less to be stable. v) Maize production in Bangkalan, on the other hand, experienced remarkable fluctuations.

Secondly, annual fluctuation of 7 crop kinds in Sampang during 1969 to 1980 was studied, and the results of 5 crops are shown in Fig. 7. The following facts were ascertained from the analysed data: i) The total yield of paddy rice increased remarkably from 1977 to 1980. ii) The amount of sweet potato remarkably increased from 1979 to 1980. iii) The production of cassava and maize increased gradually. iv) Peanut and gram

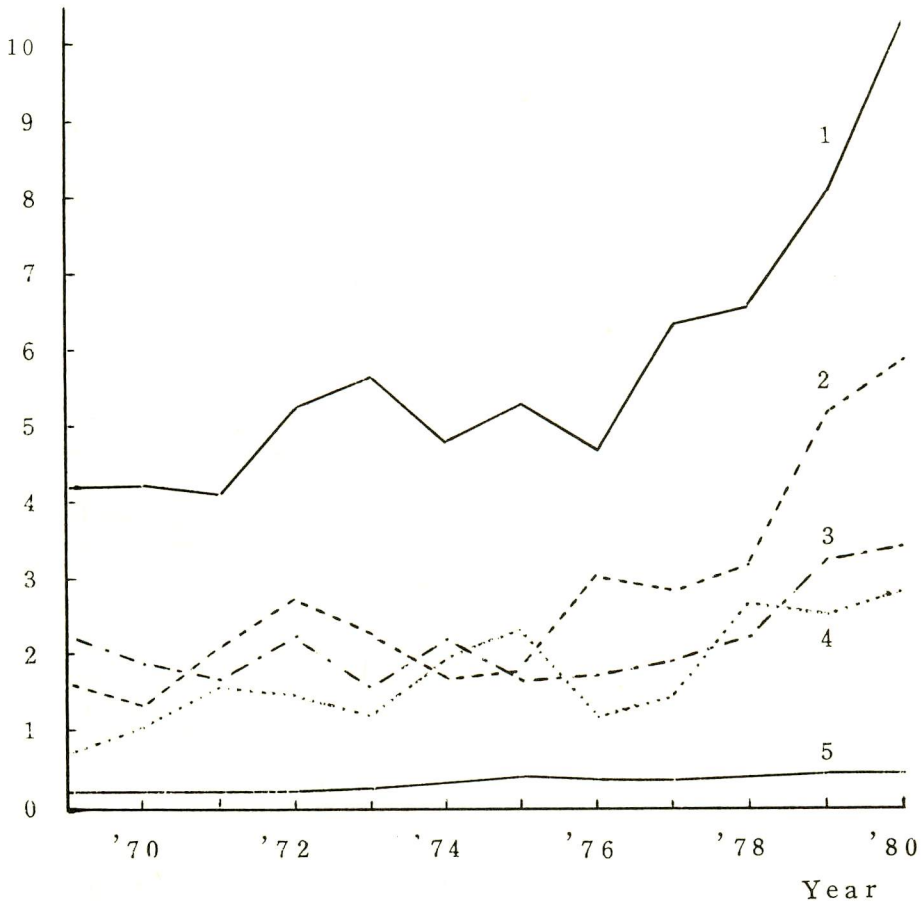


Fig. 7. Yearly fluctuations during 1969 to 1980 of 5 crop productions in Sampang. 1; paddy rice. 2; sweet potato, 3; cassava, 4; maize, 5; peanut. Gram was omitted in the figure, because its pattern was found to be quite the same as that of peanut. $\times 10,000$ ton, but $\times 100,000$ ton in cassava.

production (no figure) was little but relatively stable. v) Annual fluctuations of 4 crop kinds were remarkably recognized. vi) The product of sorghum (no figure) increased considerably during the last 10 years.

Thirdly, annual fluctuations of 7 crop kinds in Sumenep during 1963 to 1979 were calculated, and 5 crops are shown in Fig. 8. Upland rice was omitted, because the pattern of upland rice production was found to be the same as that of peanut. Similarly, gram production was also omitted, because data of this crop was available only from 1973 to 1979. From this figure, the following facts were ascertained: i) Most of crop kinds showed remarkable annual fluctuations. ii) The 7 crops can be divided into 4 groups, *i.e.*,

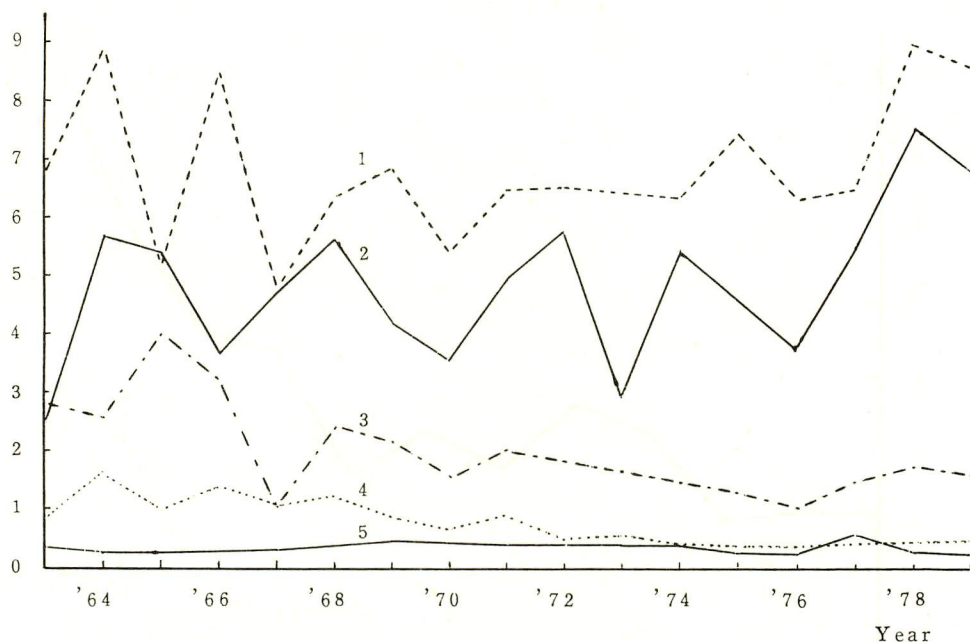


Fig. 8. Yearly fluctuations during 1963 to 1979 of 5 crop productions in Sumenep. 1; maize, 2; paddy rice, 3; cassava, 4; sweet potato, 5; peanut. Upland rice was omitted in the figure, because this pattern was found to be the same as that of peanut. Gram was also omitted, because data of this crop was available only during 1973 to 1979. $\times 10,000$ ton, but $\times 100,000$ ton in cassava.

abundant product and increase --- paddy rice, maize and gram; abundant and decrease --- cassava; small products and decrease --- upland rice; small products and constant --- sweet potato and peanut. iii) In view of the total products by short terms, the respective years were divided into 3 groups, which showed the remarkable changes in comparison with the preceding years, *i.e.*, some crops increase and others decrease --- 1964 (\uparrow maize and paddy rice, \downarrow cassava), 1966 (\uparrow maize, \downarrow paddy rice), 1967 (\uparrow paddy rice, \downarrow maize and cassava), 1975 (\uparrow maize, \downarrow paddy rice, gram and cassava); all increase --- 1968, 1971, 1978 (maize, paddy rice and cassava), 1977 (maize, paddy rice, cassava and gram); all decrease --- 1970 (maize, paddy rice and cassava), 1976 and 1979 (maize, paddy rice, cassava and gram). These phenomena could be explained by the environmental conditions and cropping systems.

6. Agricultural program for a year

In view of agricultural program for a year, the data obtained in the whole of East Java²⁾ were plotted in Figs. 9 and 10, and used for analyses.

1) Planted areas

Areas planted of 6 crops, *i.e.*, rice, maize, cassava, sweet potato, peanut and soybean,

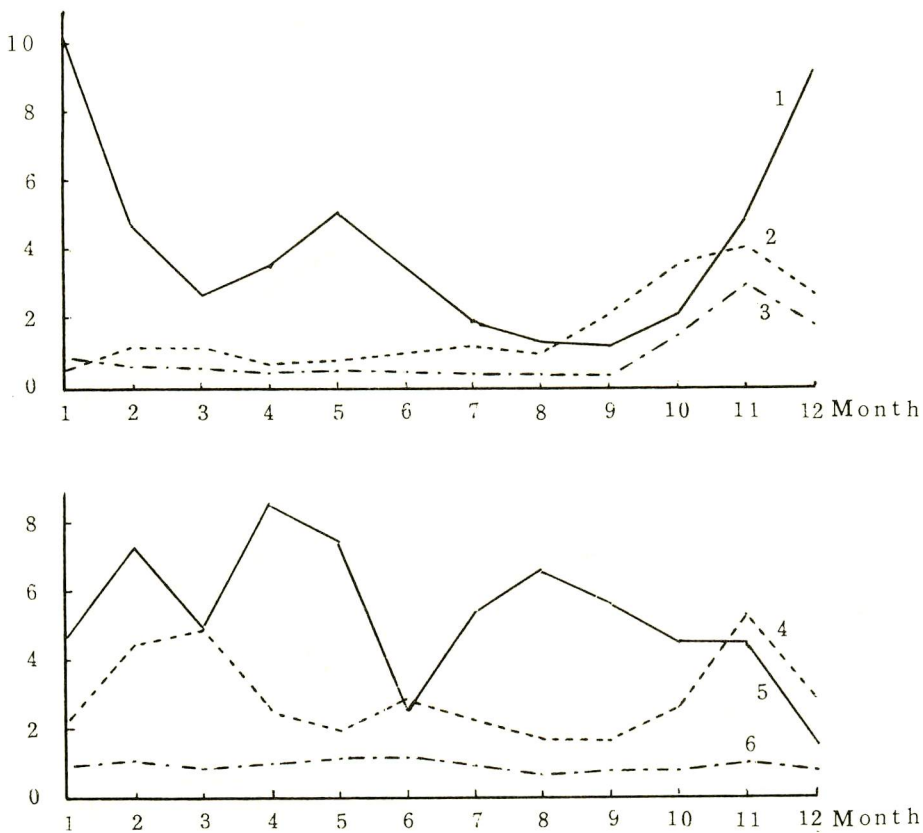


Fig. 9. Changing the planting areas during a year. 1; rice, 2; maize, 3; cassava, 4; peanut, 5; soybean, 6; sweet potato. $\times 10,000$ ha and $\times 1,000$ ha in the upper and the lower columns, respectively.

are shown in Fig. 9. They are temporarily divided into 2 groups, *i.e.*, major crops --- rice, maize and cassava, and minor crops --- soybean, peanut and sweet potato. The former and the latter are shown in the upper and the lower columns of the figure, respectively. The following facts were ascertained from the graphs in Fig. 9: i) Though there were light and shade during cropping periods, some crops were invariably planted during a year. ii) Cropping periods of sweet potato were found to be constant status during a year. iii) Patterns of planting periods of rice were found to be reversely related to those of peanut and soybean. iv) Planting periods of maize were the same as in case of cassava. v) The following five crops constituted the extensive planting periods: rice (48.2%), maize (49.5%), cassava (61.4%), soybean (36.5%) and peanut (41.8%) during the main 3 months. The major (rice, maize and cassava) and the minor (soybean, peanut and sweet potato)

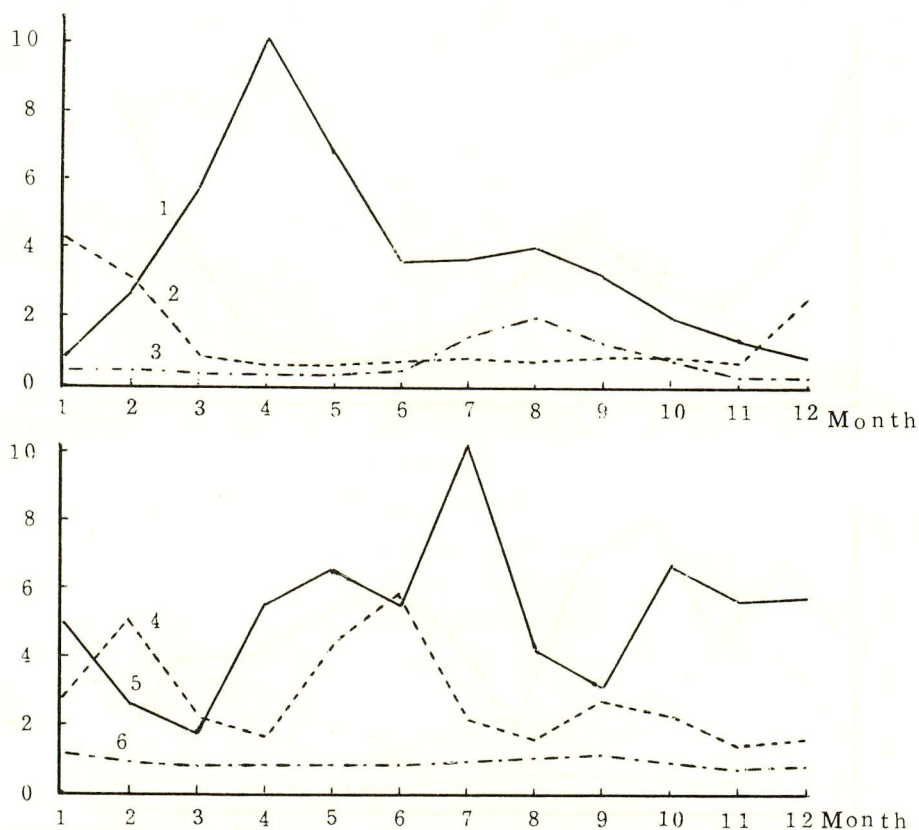


Fig. 10. Changing the harvesting areas during a year. Number of crop kinds and scale of areas are the same as that of Fig. 9.

crops were planted 46.2% and 32.4% of the total plants during the main 3 months, respectively, which were denoted as November, December, January, and February, April, November, respectively. The six crops were planted 43.4% of the total planted areas during November, December and January. It was apparent that periods of sweet potato and the remaining 5 crops showed nonseasonal and seasonal characteristics, respectively.

2) Harvested areas

Areas harvested of 6 crops were plotted, and are shown in Fig. 10. From this figure, the following facts were ascertained: i) Though there were light and shade for harvesting periods, some crops were invariably harvested during a year. It meant that there were not found a serious period of short supply or an off-crop season, which was planned by the farmers as fundamental cropping systems. ii) Harvesting periods of sweet potato were found to be constant status during a year, and similarly of the planting period. iii) At the

preharvest month of rice, harvesting of maize and soybean was regarded as very important farm activity. iv) The five crops which constituted the 3 months extensive harvesting period were rice (50.4%), maize (60.7%), cassava (56.8%), soybean (36.8%) and peanut (45.1%).

The major crops which were harvested in March, April and August and the minor crops in May, June and July made up to the following composition, 35.4% and 34.5% of the total harvest, respectively. All the 6 crops were harvested 34.9% of the total plants during the main 3 months, which were denoted as March, April and May.

3) Sum-up of planted and harvested areas

Planted and harvested areas of the all 6 crops were summed-up during a year. Farmers were concerned with 6 main crops at the working rates of 10.9%, 8.7%, 7.5%, 10.3%, 9.4%, 6.6%, 6.7%, 6.2%, 6.1%, 7.3%, 9.5% and 10.9% in the order from January to December, respectively, with a mean value and standard deviation of 8.33 ± 1.75 . It was noted that the largest value was found to be fewer than twice the smallest value. These values were found to be 8.33 ± 3.85 and 8.33 ± 3.10 in planting and harvesting areas, respectively. It was observed that standard deviations were smallest in summed-up data compared to individual data. In other words, the farmers were concerned with 6 crops, more or less, through a year, without exception, though they also attached much importance to some crop kinds.

PART II. Some aspects on cropping systems

As mentioned in PART I, rice cultivation plays an important role in agriculture in Madura Island⁴⁾. SUDJADI (1970)⁸⁾ has already reported cultivating system for rice, hence in this chapter crops other than rice are discussed in relation to climatic conditions, kinds of crops, alternations, mixed cropping, cover crops and reclamation. Most of the meteorological data were described on the records obtained in Surabaya.

1. *Climatic conditions*

The yearly average temperature was recorded as 27.0°C. Monthly average temperatures vary from 28.1°C in November to 25.9°C in July and August in Madura Island. Temperature is not a critical factor which limits the cultivation of the several common crops here.

Rainfall was recorded as 1,285 mm for the average yearly total. The maximum monthly average rainfall (=279 mm) was recorded in February while the minimum (= 5 mm) was reported in August and September. It is characteristic of this island that the rainfall varies considerably from month to month and hence from year to year.

In view of average rainfall pattern during a year, it can be said that cultivation of some crop kinds are possible more or less throughout a year. However, continuous non-rainfall days, which are common to these areas, are worthy of attention, because they fundamentally affect the agricultural practices. Irrigation systems work out a solution of these water troubles, *i.e.*, main, secondary and tertiary water courses. Practically, hydrographic settlements are under constructions in several places, for example, in Lenteng Timur, Ambunten, Kedungdung, Blega, Kwanyar, Bangkalan, Burneeh and Socah.

Even no irrigation system and only rainfed areas, upland rice was cultivated in the areas having more than 1,000 mm rainfall in a year.

Wind velocities were recorded as 0–3 m/sec for a year. More than 5 m/sec is little chance.

Sunshine hours were recorded in "percentage of possible" as follows; January (71%), February (63), March (58), April (81), May (71), June (86), July (98), August (99), September (89), October (89), November (76) and December (65). Average sunshine with a standard deviation through a year was found to be 78.83 ± 13.05 . Solar energies were recorded as 250 – 400 kcal/cm² and 450 – 500 kcal/cm² in wet and dry seasons, respectively³⁾. These values indicate that there was sufficient solar energy for cultivation of several crop kinds during a year in these areas.

2. *Kinds of crops used*

During the short trip in Madura, the following 64 common crops were found being grown in this area. They were listed up in alphabetical order as follows: amaranthus, bamboo, banana, black gram, bread fruit, broad bean, cabbage, cactus, caespitosum, cassava, cashewnut, Chinese chive, clove, coconut palm, coffee, common sunflower, cotton, cowpea, cucumber, eggplant, garlic, ginger, green gram, kapok, kidney bean, leaf mustard, logan, maize, mango, mangosteen, medical plant kinds, mung bean, onion, oranges, papaya, pea, peanut, pearl millet, pepper, pigeon pea, pineapple, potato, pumpkin, radish, red pepper, rice, sapodilla, sesame, sisal, sorghum, soybean, sugarcane, sweet potato, sword bean, taro, tobacco, tomato, water convolvulus, watermelon, water rose apple, Welsh onion, white mustard, winged bean, yam. Though most of the crops mentioned above can not be found in the formal statistical records, they were fundamentally regarded as very important food crops. These included various types of vegetables, fruits, fibre, medical plants and/or industrial crops, which succeeded from generation to generation, owing to very favourable environmental conditions and long conventions in these areas.

The life cycles of the individual crops are well known to be shorter than half a year,

except some crop kinds besides the ones mentioned above, hence they are found in other seasons. In addition to these crop kinds, it is said, moreover, that some crop kinds had been commonly cultivated in these areas in the past, but now they are abandoned and eliminated at the present time, owing to changes in taste, economical stress, etc. In other words, the farmers in Madura Island have, however, abundance of resources in agricultural practices during a year from place to place. These facts supported and maintained the following colorful variations in agricultural background.

3. *Program of cropping systems during a year*

Examples of cropping systems, which were ascertained to be a popular pattern in the same farm land during a year, were shown as follows: tobacco → peanut → maize, maize → gram → cassava. It was noticeable that cassava was adopted for these cropping system in the latter case, because its growing period was detected as only 8 months. This variety was recently produced by the governmental institute. It was suggested that selection and breeding of the new varieties of adequate crop kinds having relatively short duration, *i.e.*, photoperiodically insensitive characters, were requested for the development and stability of these cropping systems.

The following items were important to consider for these combinations. It was generally accepted that some crops showed good growth and harvest but some crops showed poor growth and harvest, in accordance with the preceding crop kinds. For example, rice showed good growth after tobacco, but bad growth after sugarcane. These facts were attributable to soil constitution and growing patterns of the preceding crop kinds.

4. *Alternating and mixed cropping systems*

It was a familiar sight in south and southeast Asia that 2 or 3 crops were cultivated on the same place of land with alternating or mixed cropping systems. Alternating cropping system means that different crop kinds were separately sown or transplanted in the alternating rows or furrows. Mixed cropping system means that different crop kinds were sown or transplanted at the same time or one was sown or transplanted after sprouting of the former one. This method has been reported for maize and cassava⁹⁾. From the present study, the following crop combinations were most popular styles in these areas: cassava – tobacco, cassava – sweet potato, cassava – maize, cassava – peanut, cassava – pigeon pea, cassava – pepper, cassava – orange, cassava – taro, maize – kidney bean, maize – peanut, maize – sorghum, maize – soybean, peanut – tobacco, tobacco – taro, soybean – kidney bean. These crop kinds were adapted as alternating and/or mixed cropping systems.

The following merits were, in general, ascertained in these systems: i) improvement

of utilization rate on arable land, ii) decrement of lodging, iii) improvement of green color, iv) prevention of period of short supply. v) Moreover, it was ascertained as one of the merit that one of two or three crop kinds can live when the other crop kind was perfectly damaged by some obstacles, *i.e.*, drought, insect, fungi, saline, strong wind.

These alternating and mixed cropping systems have a long history in these areas, especially maize – kidney bean and soybean – kidney bean combinations.

Climbing stem of pea twined about pole of cassava. Some medical crops twined also about stem of several grain crops. These patterns were found in abundant combinations, *i.e.*, as an arm --- banana, cassava, maize, pea, sorghum; and as a twiner --- cowpea, medical plant, sword bean, white mustard, winged bean, yam. These patterns were looked upon by virtue of alternating and mixed cropping systems as one of the agricultural systems, which had been practised in these areas for a long time.

5. *Cover crops*

Shading technique is said to play a very important role for some crop kinds during the young stage or during the whole life cycle. These relations were characterized as 4 items in these areas: i) The following combinations were referred to as these relations (the former --- cover crop, the latter --- shaded crop), *i.e.*, orange – cassava, coconut palm – banana, coconut palm – cassava, coconut palm – kidney bean, coconut palm – soybean, coconut palm – pigeon pea, cassava – sweet potato, cassava – pepper, maize – cassava. ii) Some crops were used as cover crop in some cases, and as shaded crop in other cases. For example, pigeon pea was shaded by coconut palm in some cases (= shaded crop), but covered sweet potato in other cases (= cover crop). iii) Purpose of “cover – shaded” relations were at first aimed only for young growing stage of the shaded crop kind. For example, cassava covered naturally pigeon pea only during young growing stages, and pigeon pea was subjected to open field condition after harvesting cassava. As the second step, almost all of the relations were adopted during the whole life cycle of both crops. For example, coconut palm covered kidney bean during the whole life cycle of the latter crop. iv) Re-combination of “cover – shaded” relations and alternating cropping systems were ascertained in several localities at the same time. Maize – cassava and cassava – pigeon pea cropping systems were undertaken covered by oranges or coconut palm. These complex techniques were found to be effective in tropical and subtropical regions, which could be explained as involutinal and additional efficiencies of both systems.

6. *Reclamation of cultivating land*

In Madura Island, cultivation of several crops were done not only in mature field but also in the “waste land” and sandy areas. Tobacco, cactus, cassava, sweet potato, sorghum and cotton were the representative crop kinds in these areas. But, these crops were

generally found only sporadically and showed relatively poor growth. These "waste" lands were reclaimed little by little as arable land by constant effort of government officials and farmers.

It was noteworthy as a reclamation technique that the "waste" land near Kwanyar was regenerated as arable land. This area was dug and the soil heaped up systematically. The lower section was used as paddy field and the upper portion was used as upland field. The latter was adopted for cultivation of several crop kinds, and was protected by the paddy field from several stresses, e.g., animals, flood damages. Production of the upper portion was detected successfully as follows: pepper > caespitosum > peanut > cassava > banana > sweet potato. Rice production in the lower part showed reasonable yield.

7. *Other topics*

Lands other than so-called farm land were also used for agricultural practices. Several patterns of cultivation are interpreted as effective ones in these areas: i) Taro and peanut were cultivated on riverbank and sandbank. ii) Pigeon pea was sown on road side ditches as "border crop". iii) Banana and cassava were planted in the ridge and levee as "anchor crop". iv) Banana was planted on high ridge and coast.

These techniques of utilizing land have several benefits individually, *i.e.*, increase of utilization of unarable land, usage as hedge, forage crop for some animals, protection of crops from "injury by continuous cultivations", bordering crop, utilizing bank of rivers and sandy areas, plastering bank after harvest, etc. Almost all of the crop kinds used in this sense could play an important role during food famine as "emergency crop".

Summary

During the period from June to July 1981, a survey of the agricultural practices in Indonesia was made. Observation was made in Middle Java, East Java and Bali Island for the comparative discussion. The results obtained in Madura Island, one of the 7 prefectures of East Java Province, are briefly reported as a comparative study in this paper. The report was divided into 2 parts, *i.e.*, records based on the statistical data, and considerations based on interviews and observations. The results obtained are summarized as follows:

Statistical analyses : The largest shares of products in Madura Island for the whole of East Java was of gram (38.91%) and the smallest portion (3.30%) was constituted by paddy rice. This tendency meant that traditional agricultural systems were still maintained and practised in Madura Island. The total product of rice was also peculiarly small in Madura. From the viewpoints of % composition of the total products, cassava,

maize, paddy rice and paddy rice in wet season made up to 46.6%, 15.8%, 14.1% and 11.6%, respectively, in the whole of Madura. The relative shares of the respective crop kinds varied from district to district in all the 4 districts of Madura, though cassava was found to be the most dominant crop. Main crops showed remarkable annual fluctuation from year to year. Although the farmers attached much importance to some crop kinds, they were more or less concerned with 6 crops (paddy rice, sweet potato, cassava, maize, sorghum and peanut) through a year.

Cropping systems : At least 64 common crop kinds were ascertained as "cultivating status" in Madura during this short trip. Though most of the crops can not be found in the official statistical data, they are regarded as very important crops in these areas. The fact that having more crop kinds means that the agriculture and food types enrich the contents and varieties. Rural and traditional cropping systems were maintained without monocultural cropping systems. Sometimes some of the crops compensated due to the lack of other crops, and these complex cropping systems can get through several barriers. Several contrivances on agricultural practices were found out here, e.g., alternating and mixed cropping systems, relay cropping, cover cropping and reclamations.

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