# Some Aspects on Rice Cultivation in East Java, Indonesia, especially on Madura Island

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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 as "Ecological biology and the promotion on tropical primary industry", supported by a grant from the Ministry of Education, Japan. Rice cultivation in East Java was studied from several viewpoints. Observations were also made in Middle Java and Bali Island for the extensive comparisons, and the results obtained in East Java are briefly reported in the present paper.

Several research reports on rice cultivation in Indonesia, especially in Java Island, have been reported [7,11]. However, no distinct record was reported on Madura Island, East Java Province. In this paper, rice cultivation is divided into grain morphology, statistical record and cultivating systems. It is said that improved varieties of the *indica* type of rice are being cultivated and that primitive types of *indica* and *javanica* are not used in these areas at present. However, it is not certained whether the same can be said for Madura.

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## Materials and Methods

Twenty-nine strains of rice strains collected in East Java were used in this experiment. Thirty grains were used for each strain. Measurements were taken of length, width and thickness of unhusked grains at the largest points of the respective characters. Further calculations were done for determine the ratios of length to width, of length to thickness and of width to thickness.

For the analyses of the production and their characteristics of the rice, statistical reports published by the governments concerned [1,2] and scientists [6] were used. Several data found in these publications were rearranged and analysed for comparison with locality characteristics and other crop kinds.

For discussion on combinations of rice with other crop kinds, alternating cropping systems, multi-cropping systems, relations between rice cultivation and seasonal changes,

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and other items, data obtained from observations and hearings were used.

## Results and Discussion

### 1. Grain morphology

On the grain morphology of rice strains, some reports have been published[8]. However, no distinct record has been reported on the grain morphology of cultivated rice varieties in Madura Island, East Java, Indonesia. In these districts, several cultivated rice, *Oryza sativa* L., are used in lowland and upland fields. Most of them are introduced from Java proper, Bali, India, the Philippines and others. Twenty-nine varieties of cultivated rice in these areas were collected and used for morphological investigations. They are listed up in Table 1. The results of the investigations are given below.

1. Lengths of grains ranged from 10.33 mm (No. 25) to 7.56 mm (No. 11) in the strain average (Table 2). There were great differences in length between strains. The average and standard deviation of all the 29 strains was found to be $8.96 \pm 0.78$. The standard deviation of each strain, *i. e.*, intra-population's variations, ranged from 0.88 (No. 17) to 0.13 (No. 11). The range for No. 17 was particularly large. These averages and their standard deviations were found to be $0.31 \pm 0.16$. In all the strains recommended in all the Indonesia[10] (abbreviated as the whole Indonesia, and so forth), lengths ranged from 11.24 mm to 6.46 mm, and their average was found to be 8.70 mm. Standard deviations of each strain were found to be $0.36 \pm 0.15$.

2. Widths of grains ranged from 3.29 mm (No. 13, red grains) to 2.32 mm (No. 4). The average and standard deviation of all the 29 strains was found to be $2.74 \pm 0.28$. The standard deviation of each strain ranged from 0.24 (No. 2) to 0.05 (Nos. 8 and 25). It was noted that the value was particularly large in No. 2. These averages and their standard deviations were found to be $0.11 \pm 0.05$. In all the Indonesia, widths ranged from 4.28 mm to 2.35 mm, and their average was found to be 3.09 mm. Standard deviations of each strain were found to be $0.12 \pm 0.07$.

3. Thicknesses of grains ranged from 2.37 mm (No. 14, red grains) to 1.62 mm (No. 18). The average and standard deviation of all the 29 strains was found to be $2.01 \pm 0.18$. The standard deviation of each strain ranged from 0.17 (No. 1) to 0.03 (No. 8). These averages and their standard deviations were found to be $0.08 \pm 0.04$. In all the Indonesia, thicknesses ranged from 2.62 mm to 1.69 mm, and their average was found to be 2.06 mm. Standard deviations of each strain were found to be $0.07 \pm 0.01$.

4. L/W (ratio of length to width) ranged from 4.03 (No. 18) to 2.46 (No. 11). The average and standard deviation of all the 29 strains was found to be $3.31 \pm 0.47$. The standard deviation of each strain ranged from 0.39 (No. 23) to 0.06 (No. 8). These averages and their standard deviations were found to be $0.18 \pm 0.07$. In all the Indonesia, L/W ranged from 4.08 to 1.86.

5. L/T (ratio of length to thickness) ranged from 6.22 (No. 18) to 3.45 (No. 11). The average and standard deviation of all the 29 strains was found to be $4.50 \pm 0.53$. The standard deviations of each strain ranged from 0.83 (No. 17) to 0.06 (No. 8). These averages and their standard deviations were found to be $0.23 \pm 0.16$. In the whole Indonesia, L/T ranged from 5.48 to 3.18.

Table 1. Locality and habitat of the cultivated rice, *Oryza sativa* L., collected in East Java

| Collection No. | Date | Place | Detailed locality, habitat, local name and remarks |
|---|---|---|---|
| 1 | June 28 | Galis | Swampy area, near TAMBAK. |
| 2 | June 29 | Gapura | Breeding Station. So called C4. |
| 3 | July 2 | Gandung | Rice terraces, dominant strain in their areas. |
| 4 | July 2 | Camplon | Near seashore. Cultivating tobacco, corn and cassava in near farms. |
| 5 | July 4 | Sampang | Southwest from Sampang. Well managed paddy field. |
| 6 | July 4 | Sampang | Same locality as above. Near field growing *Miscanthus* sp. |
| 7 | July 4 | Sampang | Same locality as above. Near pond. |
| 8 | July 4 | Terenggi | South from Terenggi. Shallow water paddy field. |
| 9 | July 4 | Terenggi | Same locality as above. Sporadically with No. 8. Long awn. |
| 10 | July 4 | Terenggi | Same locality as above. |
| 11 | July 4 | Terenggi | Same locality as above. Sporadically with No. 10. Violet long awn. |
| 12 | July 4 | Terenggi | Same locality as above. |
| 13 | July 4 | Terenggi | Same locality as above. Red grain. Long awn. |
| 14 | July 5 | Sampang | TAMBAK near Sampang. Red grain. Long awn. |
| 15 | July 5 | Sampang | Same locality as above. |
| 16 | July 5 | Kwanyar | Northwest from Kwanyar. Shallow water paddy field. |
| 17 | July 6 | Bangkalan | SAWAH TAMBAK. Medical crop growing near field. |
| 18 | July 6 | Socah | Swampy field. Advanced strain growing near field by embankment. |
| 19 | July 7 | Tragar | Northwest from Kwanyar. |
| 20 | July 7 | Tragar | Same locality as above. |
| 21 | July 7 | Tragar | Same locality as above. Red grain. |
| 22 | July 7 | Tragar | Same locality as above. Red grain. |
| 23 | July 7 | Tragar | Same locality as above. |
| 24 | July 7 | Burneh | Southwest from Burneh. Mixed growing with Nos. 25-27. |
| 25 | July 7 | Burneh | Same locality as above. |
| 26 | July 7 | Burneh | Same locality as above. Long awn. |
| 27 | July 7 | Bruneh | Same locality as above. |
| 28 | July 14 | Jenu | Shallow water paddy field. So called Niara. Black grain. |
| 29 | July 15 | Lamongan | 4 kilometers east from Lamongan. TAMBAK. Premature harvesting. |

6. W/T (ratio of width to thickness) ranged from 1.78 (No. 1) to 1.16 (No. 15). The average and standard deviation of all the 29 strains was found to be $1.37 \pm 0.12$. The standard deviation of each strain ranged from 0.16 (No. 6) to 0.03 (Nos. 8 and 10). These averages and their standard deviations were found to be $0.09 \pm 0.04$. In all the Indonesia, W/T ranged from 2.13 to 1.30.

7. According to the classification noted by MATSUO[9], the strains used here can be divided into two groups (Fig. 1); type B (=large type or *javanica* type) – Nos. 14, 26 and 28 (10.3 % in the whole), type C (=slender type or *indica* type) – the remaining 26 strains (89.7 % in the whole), type A (=short type or *japonica* type) – none. On

Table 2. Six characters of unhusked grains

| Strain No. | Length (mm) | Width (mm) | Thickness (mm) | L/W | L/T | W/T |
|---|---|---|---|---|---|---|
| 1 | 7.69 ± 0.21 | 2.91 ± 0.06 | 1.65 ± 0.17 | 2.66 ± 0.13 | 4.72 ± 0.54 | 1.78 ± 0.19 |
| 2 | 9.65 ± 0.37 | 2.65 ± 0.24 | 2.03 ± 0.08 | 3.66 ± 0.21 | 4.77 ± 0.14 | 1.31 ± 0.10 |
| 3 | 9.11 ± 0.23 | 2.46 ± 0.10 | 1.93 ± 0.04 | 3.72 ± 0.17 | 4.73 ± 0.13 | 1.28 ± 0.07 |
| 4 | 7.73 ± 0.23 | 2.32 ± 0.09 | 1.72 ± 0.08 | 3.35 ± 0.20 | 4.51 ± 0.18 | 1.35 ± 0.10 |
| 5 | 8.79 ± 0.17 | 2.57 ± 0.20 | 2.05 ± 0.12 | 3.44 ± 0.29 | 4.31 ± 0.25 | 1.26 ± 0.15 |
| 6 | 9.99 ± 0.34 | 2.60 ± 0.09 | 2.02 ± 0.16 | 3.85 ± 0.15 | 4.98 ± 0.55 | 1.30 ± 0.16 |
| 7 | 9.23 ± 0.36 | 2.63 ± 0.11 | 1.95 ± 0.04 | 3.51 ± 0.16 | 4.74 ± 0.25 | 1.35 ± 0.06 |
| 8 | 8.47 ± 0.16 | 2.98 ± 0.05 | 2.13 ± 0.03 | 2.85 ± 0.06 | 3.98 ± 0.06 | 1.40 ± 0.03 |
| 9 | 8.02 ± 0.29 | 3.06 ± 0.07 | 2.12 ± 0.04 | 2.62 ± 0.07 | 3.78 ± 0.15 | 1.45 ± 0.04 |
| 10 | 9.66 ± 0.35 | 2.55 ± 0.07 | 2.05 ± 0.04 | 3.80 ± 0.18 | 4.72 ± 0.14 | 1.25 ± 0.03 |
| 11 | 7.56 ± 0.13 | 3.08 ± 0.11 | 2.20 ± 0.08 | 2.46 ± 0.11 | 3.45 ± 0.16 | 1.40 ± 0.04 |
| 12 | 9.34 ± 0.22 | 2.65 ± 0.10 | 1.95 ± 0.05 | 3.53 ± 0.15 | 4.79 ± 0.18 | 1.36 ± 0.07 |
| 13 | 8.38 ± 0.20 | 3.29 ± 0.12 | 2.26 ± 0.07 | 2.55 ± 0.11 | 3.72 ± 0.12 | 1.46 ± 0.08 |
| 14 | 9.22 ± 0.30 | 3.28 ± 0.19 | 2.37 ± 0.09 | 2.82 ± 0.16 | 3.90 ± 0.23 | 1.39 ± 0.12 |
| 15 | 9.70 ± 0.37 | 2.57 ± 0.08 | 2.23 ± 0.05 | 3.80 ± 0.18 | 4.36 ± 0.13 | 1.16 ± 0.05 |
| 16 | 8.32 ± 0.32 | 3.07 ± 0.09 | 2.00 ± 0.10 | 2.72 ± 0.16 | 4.17 ± 0.35 | 1.54 ± 0.08 |
| 17 | 9.00 ± 0.88 | 2.33 ± 0.12 | 1.73 ± 0.15 | 3.86 ± 0.24 | 5.23 ± 0.83 | 1.35 ± 0.13 |
| 18 | 10.07 ± 0.17 | 2.50 ± 0.08 | 1.62 ± 0.06 | 4.03 ± 0.14 | 6.22 ± 0.22 | 1.55 ± 0.10 |
| 19 | 8.06 ± 0.43 | 2.89 ± 0.16 | 2.05 ± 0.06 | 2.79 ± 0.21 | 3.93 ± 0.20 | 1.41 ± 0.10 |
| 20 | 8.55 ± 0.23 | 2.78 ± 0.11 | 1.99 ± 0.11 | 3.09 ± 0.17 | 4.31 ± 0.21 | 1.40 ± 0.11 |
| 21 | 8.35 ± 0.19 | 2.63 ± 0.09 | 1.94 ± 0.04 | 3.19 ± 0.15 | 4.32 ± 0.11 | 1.36 ± 0.06 |
| 22 | 9.49 ± 0.38 | 2.78 ± 0.17 | 2.10 ± 0.06 | 3.44 ± 0.33 | 4.53 ± 0.19 | 1.33 ± 0.11 |
| 23 | 9.07 ± 0.62 | 2.42 ± 0.13 | 1.97 ± 0.11 | 3.77 ± 0.39 | 4.62 ± 0.23 | 1.24 ± 0.12 |
| 24 | 9.46 ± 0.38 | 2.61 ± 0.11 | 2.00 ± 0.06 | 3.63 ± 0.15 | 4.75 ± 0.23 | 1.31 ± 0.06 |
| 25 | 10.33 ± 0.29 | 2.66 ± 0.05 | 2.05 ± 0.05 | 3.86 ± 0.14 | 5.04 ± 0.23 | 1.30 ± 0.04 |
| 26 | 9.84 ± 0.33 | 3.04 ± 0.07 | 2.20 ± 0.04 | 3.24 ± 0.11 | 4.48 ± 0.13 | 1.38 ± 0.04 |
| 27 | 9.14 ± 0.48 | 2.66 ± 0.13 | 2.04 ± 0.08 | 3.45 ± 0.24 | 4.49 ± 0.25 | 1.31 ± 0.05 |
| 28 | 9.55 ± 0.17 | 3.15 ± 0.14 | 2.20 ± 0.08 | 3.04 ± 0.16 | 4.34 ± 0.14 | 1.44 ± 0.10 |
| 29 | 8.05 ± 0.18 | 2.42 ± 0.10 | 1.72 ± 0.04 | 3.34 ± 0.17 | 4.69 ± 0.12 | 1.41 ± 0.08 |

the other hand, the whole Indonesia's strains were divided as follows[10]; 10 strains (4.45%) belonging to type A, 59 strains (25.99%) belonging to type B, 158 strains (69.60%) belonging to type C.

8. In comparison with the present and the past data in view of strain differentiations, the following facts were ascertained. i) Lengths of the present materials were remarkably longer than that of the whole Indonesia. ii) Widths of the present materials were remarkably narrower than that of the whole Indonesia. iii) Thicknesses of the present materials were nearly the same with that of the whole Indonesia. iv) Variations of length in the present materials were clearly smaller than that of the whole Indonesia. v) Variations of width and thickness in the present materials were nearly the same with that of the whole Indonesia. In comparison with the data of the whole Indonesia, the materials in the present study would be located in the portion as relatively slender and narrower variations.

9. In view of the standard deviations found in the respective strains, it was reasonably said that some one showed relatively large and small intra-population's

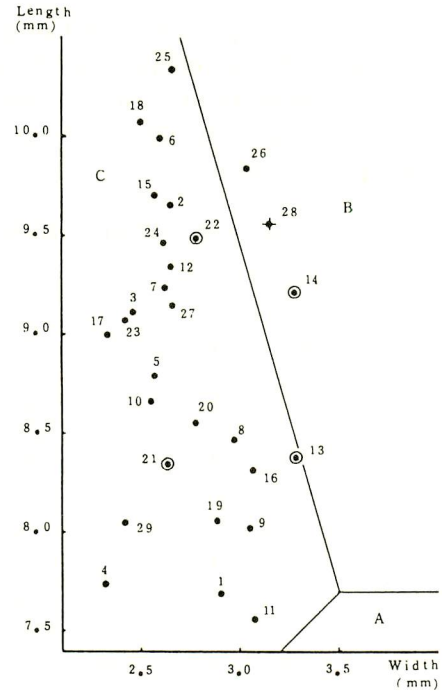


Fig. 1. Relation between length and width of unhusked grains in mm. Vertical axis ; length of grain, abscissa ; width of grain. Code numbers used in figure correspond to the strain number, which was used in Table 1. ⊙ : Red grain, ✦: black grain, ● : white grain

variations. The former is said as one located in genetically unstable status. The latter is said as one located in genetically stable status. For example, No. 17 collected at *SAWAH TAMBAK* near Bangkalan showed the very large variations. In these area, the materials were used in very large areas and looked upon yet being selecting stage. On the other hand, No. 8 collected in shallow water paddy field near Terenggi showed the small variations. Such materials are constantly used in these areas and looked upon having the long history.

## 2. Statistical aspects

Productivities of rice were analysed for of the whole East Java and Madura Island, using the formal statistical records[1,2,6].

1. In Table 3, productivities of 5 types of rice cultivation in the whole of East Java were analysed, and are shown in precentages ; *i.e.*, paddy rice, paddy rice in wet season (abbreviated as wet season, and so forth), paddy rice in dry season (dry season), upland rice and direct sowing culture of paddy rice on well-drained paddy field (direct sowing).

East Java consists of 7 prefectures (Fig. 2). In column A of Table 3, a figure 14.50 in Surabaya for paddy rice means that its product (993,642 ton) in Surabaya has a share of 14.50% of the whole products (6,854,430 ton) in the whole East Java. Specificities of the individual prefectures were ascertained to some extent. Seven prefectures can be divided into 4 groups, *i.e.*, 1 – Surabaya and Bojonegoro, 2 – Madiun and Kediri,

Table 3. Shares of rice productions in 7 prefectures of East Java, illustrated by shares (%) of the individual rice productions – A to the whole East Java, B to the whole productions of 12 main crops, C to the whole rice products. Direct sowing means direct sowing culture of paddy rice in well-drained paddy field.

| | | Sura-baya | Bojone-goro | Madiun | Kediri | Malang | Besuki | Madura | Whole East Java |
|---|---|---|---|---|---|---|---|---|---|
| A | Paddy rice | 14.50 | 11.23 | 15.37 | 14.50 | 17.63 | 23.48 | 3.30 | 100.00 |
| | Paddy rice in wet season | 13.51 | 12.40 | 16.40 | 14.79 | 16.94 | 22.08 | 3.89 | 100.00 |
| | Paddy rice in dry season | 14.39 | 4.59 | 13.61 | 15.27 | 21.61 | 30.01 | 0.50 | 100.00 |
| | Upland rice | 11.65 | 5.99 | 28.72 | 18.56 | 9.77 | 5.00 | 20.31 | 100.00 |
| | Direct sowing | 35.80 | 40.09 | 8.18 | 2.42 | 0.11 | 0.00 | 13.40 | 100.00 |
| | Total | 14.46 | 11.17 | 15.53 | 14.55 | 17.53 | 23.25 | 3.50 | 100.00 |
| B | Paddy rice | 37.50 | 37.89 | 33.10 | 32.95 | 32.65 | 41.59 | 14.11 | 34.70 |
| | Paddy rice in wet season | 27.47 | 29.16 | 24.61 | 23.42 | 21.86 | 27.27 | 11.60 | 24.19 |
| | Paddy rice in dry season | 11.29 | 4.17 | 8.01 | 9.35 | 10.78 | 14.32 | 0.58 | 9.35 |
| | Upland rice | 0.83 | 0.49 | 1.50 | 1.03 | 0.44 | 0.22 | 2.12 | 0.84 |
| | Direct sowing | 3.52 | 4.56 | 0.59 | 0.19 | 0.01 | 0.00 | 1.93 | 1.17 |
| | Total | 80.61 | 76.27 | 67.81 | 66.94 | 65.74 | 83.40 | 30.34 | 70.25 |
| C | Paddy rice | 49.52 | 49.68 | 48.89 | 49.23 | 49.67 | 49.87 | 46.51 | 49.05 |
| | Paddy rice in wet season | 32.16 | 38.23 | 36.35 | 34.99 | 33.26 | 32.70 | 38.23 | 35.13 |
| | Paddy rice in dry season | 13.24 | 5.47 | 11.66 | 13.96 | 16.39 | 17.17 | 1.91 | 11.40 |
| | Upland rice | 0.97 | 0.64 | 2.22 | 1.53 | 0.67 | 0.26 | 6.97 | 1.89 |
| | Direct sowing | 4.12 | 5.97 | 0.88 | 0.28 | 0.11 | 0.00 | 6.37 | 2.53 |

3 – Malang and Besuki, 4 – Madura. For the respective groups in the order from Group 1 to Group 4, direct sowing, upland rice and wet season, dry season, upland rice and direct sowing were shown as the representative cultivation-methods of rice, respectively. The differences found in the individual prefectures mainly originated in annual rainfall [4] and in water control systems [3].

It was noteworthy that 3 figures in Madura, *i.e.*, paddy rice, wet season and dry season, were found to be very small in comparison with that of the other prefectures.

Standard deviations of 5 types found in 7 prefectures were ascertained as 5.70, 5.14, 9.15, 7.98, 15.64 and 5.59 in the order of paddy rice, wet season, dry season, upland rice, direct sowing and the total. It was noteworthy that the value was particularly large in direct sowing. Ratios of their standard deviations to the average value (=14.29)

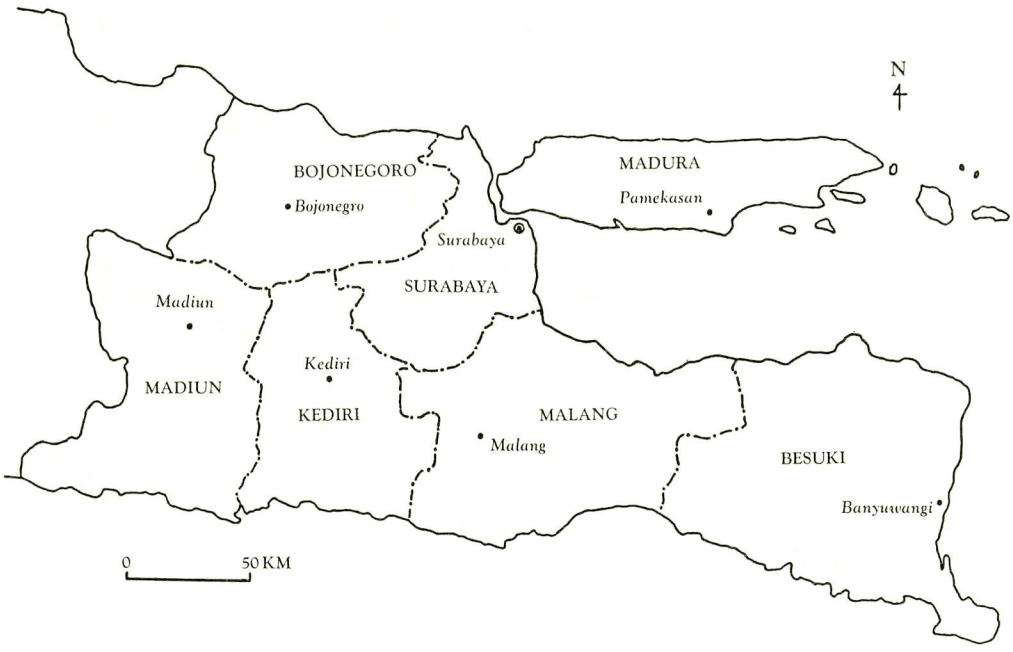


Fig. 2. Map showing constitution of East Java. Dotted line ; boundary of prefectures, roman letter ; prefecture name, italic letter ; capital of the respective prefectures

were counted as 0.46, 0.36, 0.64, 0.56, 1.10 and 0.39 in the same order. Owing to 2 items mentioned just above, it may be said that operating practices of direct sowing varied from prefectute to prefecture very much.

2. In column B of Table 3, a figure 37.50 in Surabaya for paddy rice means that its product has a share of 37.50% of the whole products in the main 12 crop kinds in Surabaya, which were consisted of maize, cassava, sweet potato, peanut, soybean, gram and sorghum in addition to 5 types of rice cultivation. The big 3 kinds of crops were ascertained in the order of Surabaya, Bojonegoro, Madiun, Kediri, Malang, Besuki and Madura prefectures, and the whole East Java as follows ; paddy rice > wet season > dry season, paddy rice > wet season > maize (7.46%), paddy rice > cassava (25.24%) > wet season, paddy rice > wet season > cassava (22.34%), paddy rice > wet season > cassava (21.63%), paddy rice > wet season > cassava (9.78%), cassava (46.62%) > maize (15.76%) > paddy rice, paddy rice > wet season > cassava (19.35%). Paddy rice had the first shares except Madura. Cassava had more or less top 3 shares except Surabaya. It was noted that the percentage in the total rice was peculiarly small in Madura (30.34%).

Averages and their standard deviations of 5 types of rice found in 7 prefectures were ascertained as $32.83 \pm 8.24$, $23.63 \pm 5.44$, $8.36 \pm 4.30$, $0.95 \pm 0.62$, $1.54 \pm 1.72$ and $67.30 \pm 16.41$ in the order of paddy rice, wet season, dry season, upland rice, direct sowing and the total, respectively. Ratios of their standard deviations to the average values were counted as 0.25, 0.23, 0.51, 0.65, 1.12 and 0.24 in the same order, respectively. They were divided into 3 groups in accordance with the stabilities in the respective prefectures, *i.e.*, stable (paddy rice, wet season and the total), medium (dry season and upland

rice) and flexible (direct sowing).

3. In column C of Table 3, a figure 49.52 in Surabaya for paddy rice means that its product has a share of 49.52% of the whole products in 5 types of rice. Remarkable differences were not found in 2 columns, *i.e.*, paddy rice and wet season. The individual data were compared with average values in the whole East Java. In Surabaya, for example, percentages were found as 13.24, 0.97 and 4.12 in dry season, upland rice and direct sowing, respectively. Those in the whole East Java were found as 11.40, 1.89 and 2.53 in the same order, respectively. So, Surabaya was finally illustrated as LSL in combinations of dry season, upland rice and direct sowing. In this sense, 7 prefectures were divided into 4 groups, *i.e.*, LSL (Surabaya and Bojonegoro), LLS (Madiun), LSS (Kediri, Malang and Besuki), SLL (Madura). These differences may partly be due to the

Table 4. Shares of rice productions in 4 districts of Madura Island, illustrated by shares (%) of the indivudual rice productions—A to the whole Madura Island, B to the whole products of 12 main crops, C to the whole rice products. Direct sowing means direct sowing culture of paddy rice in well-drained paddy field.

| | | Pamekasan | Bangkalan | Sampang | Sumenep | Whole Madura |
|---|---|---|---|---|---|---|
| A | Paddy rice | 11.85 | 30.33 | 30.99 | 26.84 | 100.00 |
| | Paddy rice in wet season | 7.77 | 33.75 | 26.90 | 31.58 | 100.00 |
| | Paddy rice in dry season | 7.42 | 44.06 | 29.22 | 19.33 | 100.00 |
| | Upland rice | 40.99 | 11.52 | 38.86 | 8.63 | 100.00 |
| | Direct sowing | 37.64 | 5.65 | 56.06 | 0.65 | 100.00 |
| | Total | 13.88 | 29.02 | 31.53 | 25.57 | 100.00 |
| B | Paddy rice | 14.57 | 19.07 | 11.87 | 12.95 | 14.11 |
| | Paddy rice in wet season | 7.86 | 17.45 | 8.47 | 12.52 | 11.60 |
| | Paddy rice in dry season | 0.38 | 1.14 | 0.46 | 0.38 | 0.58 |
| | Upland rice | 7.56 | 1.09 | 2.23 | 0.62 | 2.12 |
| | Direct sowing | 6.34 | 0.49 | 2.94 | 0.04 | 1.93 |
| | Total | 36.71 | 39.24 | 25.97 | 30.67 | 30.34 |
| C | Paddy rice | 39.70 | 48.62 | 45.70 | 48.82 | 46.51 |
| | Paddy rice in wet season | 21.42 | 44.47 | 32.61 | 47.22 | 38.23 |
| | Paddy rice in dry season | 1.02 | 2.91 | 1.77 | 1.44 | 1.91 |
| | Upland rice | 20.59 | 2.77 | 8.59 | 2.35 | 6.97 |
| | Direct sowing | 17.26 | 1.24 | 11.32 | 0.16 | 6.37 |

respective background of water management status.

Averages and their standard deviations of 5 types found in 7 prefectures were found as 49.05 ± 1.08, 35.13 ± 2.36, 11.40 ± 5.26, 1.89 ± 2.16 and 2.53 ± 2.65 in the order of paddy rice, wet season, dry season, upland rice and direct sowing, respectively. Ratios of their standard deviations to the average values were counted as 0.02, 0.07, 0.46, 1.14 and 1.05 in the same order, respectively. They were divided into 3 groups in accordance with the stabilities in the respective prefectures, *i.e.*, stable (paddy rice and wet season), medium (dry season) and flexible (upland rice and direct sowing).

4. In Table 4, productivities of 5 types in the whole Madura were analysed, and are shown in percentages, in which 5 types of rice were quite the same as that of Table 3. Madura Island is constituted by 4 districts as shown in Fig. 3. In column A of Table 4, a figure 11.85 in Pamekasan for paddy rice means that its product (26,765 ton) in Pamekasan has a share of 11.85 % of the whole products (225,926 ton) in the whole Madura. There was no remarkable difference in 4 districts in view of the respective shares. Products of paddy rice in Pamekasan and Bangkalan were found as smaller and larger than the average found in the whole Madura, and illustrated as S and L, respectively. Products of paddy rice was finally shown as SLLL in the order of Pamekasan, Bangkalan, Sampang and Sumenep. In this sense, paddy rice, wet season, dry season, upland rice and direct sowing and the total were illustrated as SLLL, SLLL, SLLS, LSLS, LSLS and SLLL, respectively. So, they were divided into 3 groups, *i.e.*, SLLL (paddy rice, wet season and the total), SLLS (dry season), and LSLS (upland rice and direct sowing). In the total, rice productions were took charges of a portion nearly equally.

Standard deviations of 5 types found in 4 districts were ascertained as 7.76, 10.25, 13.44, 14.98, 22.87 and 6.76 in the order of paddy rice, wet season, dry season, upland rice, direct sowing and the total, respectively. It was noteworthy that the value was peculiarly large in direct sowing. Ratios of their standard deviations to the average value (= 25.00) were counted as 0.31, 0.41, 0.54, 0.60, 0.92 and 0.27 in the same order, respectively. Owing to 2 items mentioned just above, it may be said that operating practices of direct sowing varied from district to district very much.

5. In column B of Table 4, a figure 14.57 in Pamekasan for paddy rice means that its product has a share of 14.57 % of the whole products in the 12 crop kinds in Pamekasan, which were constituted of maize, cassava, sweet potato, peanut, soybean,

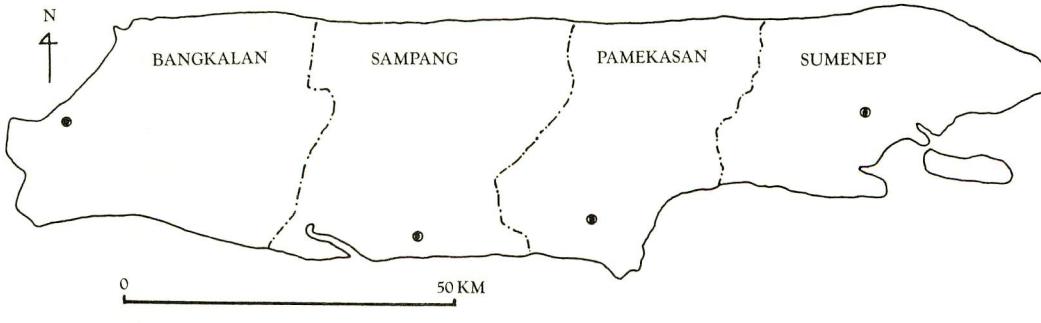


Fig. 3. Map showing constitution of Madura Island. Dotted line ; boundary of districts, letter used in the respective districts ; district name, ⊙ ; capital of the respective districts

gram and sorghum in addition to 5 types of rice cultivation. The big 3 kinds of crops were ascertained in the order of Pamekasan, Bangkalan, Sampang and Sumenep and the whole Madura as follows; cassava (44.31 %)> maize (16.56 %)> paddy rice, cassava (30.87 %)> maize (21.12 %)> paddy rice, cassava (50.36 %)> sweet potato (9.94 %)> paddy rice, cassava (43.36 %)> maize (23.43 %)> wet season, cassava (46.62 %)> maize (15.76 %)> paddy rice. Paddy rice had only the second or the third portions. Wet season had only the third portion in 1 district. Cassava had the first portion in the whole districts. The whole districts showed nearly the same values in the whole crop kinds.

Averages and their standard deviations of 5 types found in 4 districts were ascertained as 14.62 ± 2.75, 11.58 ± 3.84, 0.59 ± 0.32, 2.88 ± 2.77, 2.45 ± 2.50 and 33.15 ± 5.18 in the order of paddy rice, wet season, dry season, upland rice, direct sowing and the total, respectively. Ratios of their standard deviations to the average values were counted as 0.19, 0.33, 0.54, 0.96, 1.02 and 0.16 in the same order, respectively. They were divided into 3 groups in accordance with the stabilities in the respective districts, *i.e.*, stable (paddy rice and the total), medium (dry season and wet season) and flexible (upland rice and direct sowing).

6. In column C of Table 4, a figure 39.70 in Pamekasan for paddy rice means that its product has a share of 39.70 % of the whole products in 5 types of rice cultivations. The individual data were compared with average values in the whole Madura. In paddy rice, for example, percentages were found as 39.70, 48.62, 45.70 and 48.82 in Pamekasan, Bangkalan, Sampang and Sumenep, respectively. Average value in the whole Madura was found as 46.51. So, paddy rice was finally illustrated as SLSL in

Table 5. Yearly fluctuations during 1963 to 1979 of 6 crop productions in Sumenep

| | Paddy rice | | | Upland rice | | | Maize | | |
|---|---|---|---|---|---|---|---|---|---|
| | ha | ton | ton/ha | ha | ton | ton/ha | ha | ton | ton/ha |
| 1963 | 14,232 | 24,935 | 1.75 | 1,356 | 2,591 | 1.91 | 114,752 | 67,223 | 0.59 |
| 1964 | 15,533 | 57,365 | 3.69 | 1,104 | 1,314 | 1.19 | 173,534 | 89,871 | 0.52 |
| 1965 | 16,267 | 54,192 | 3.33 | 1,257 | 2,307 | 1.84 | 115,535 | 50,894 | 0.44 |
| 1966 | 13,057 | 36,576 | 2.80 | 1,105 | 2,262 | 2.05 | 132,029 | 86,313 | 0.65 |
| 1967 | 14,479 | 46,902 | 3.24 | 1,464 | 2,543 | 1.74 | 149,193 | 47,912 | 0.32 |
| 1968 | 15,589 | 57,216 | 3.67 | 1,495 | 2,566 | 1.72 | 151,950 | 63,700 | 0.42 |
| 1969 | 14,870 | 42,529 | 2.86 | 1,041 | 1,778 | 1.71 | 133,609 | 68,948 | 0.52 |
| 1970 | 13,477 | 35,592 | 2.64 | 1,356 | 1,738 | 1.28 | 120,981 | 54,983 | 0.45 |
| 1971 | 16,977 | 50,000 | 2.95 | 1,547 | 2,850 | 1.84 | 133,574 | 65,012 | 0.49 |
| 1972 | 16,882 | 58,126 | 3.44 | 2,749 | 5,451 | 1.98 | 129,592 | 65,812 | 0.51 |
| 1973 | 13,978 | 29,762 | 2.13 | 1,947 | 3,710 | 1.91 | 135,382 | 64,816 | 0.48 |
| 1974 | 17,448 | 54,930 | 3.15 | 1,402 | 1,124 | 0.80 | 134,310 | 63,925 | 0.48 |
| 1975 | 18,329 | 45,914 | 2.50 | 1,655 | 1,901 | 1.15 | 120,284 | 75,612 | 0.63 |
| 1976 | 16,535 | 37,789 | 2.29 | 1,365 | 2,307 | 1.69 | 98,962 | 63,796 | 0.64 |
| 1977 | 17,281 | 55,016 | 3.18 | 1,108 | 2,433 | 2.20 | 115,928 | 65,431 | 0.56 |
| 1978 | 18,355 | 75,606 | 4.12 | 1,300 | 3,620 | 2.78 | 137,749 | 90,658 | 0.66 |
| 1979 | 17,863 | 68,397 | 3.83 | 1,457 | 3,149 | 2.16 | 118,048 | 86,312 | 0.73 |

the combinations of Pamekasan, Bangkalan, Sampang and Sumenep. In this sense, 5 types were divided into 3 groups, *i.e.*, SLLS (paddy rice and dry season), SLSL (wet season), LSLS (upland rice and direct sowing), in which L and S means that the values were larger and smaller than that of the averages, respectively, in the order from Pamekasan, Bangkalan, Sampang and Sumenep combinations.

Averages and their standard deviations of 5 types found in 4 districts were ascertained as 45.71 ± 3.68, 36.43 ± 10.26, 1.79 ± 0.70, 8.58 ± 7.36 and 7.50 ± 7.12 in the order of paddy rice, wet season, dry season, upland rice and direct sowing, respectively. Ratios of their standard deviations to the average values were counted as 0.08, 0.28, 0.39, 0.86 and 0.95 in the same order, respectively. They were divided into 3 groups in accordance with the stabilities in the respective districts, *i.e.*, stable (paddy rice), medium (wet season and dry season) and flexible (upland rice and direct sowing).

7. Annual fluctuations of paddy rice and uplant rice in Sumenep, a eastern district of Madura, during 1963 to 1979 were calculated in ha, ton and ton/ha, and are shown in Table 5. In addition to these, that of maize, cassava, sweet potato and peanut are also shown for comparison with rice cultivations. According to this table, it was ascertained that the all crop kinds showed remarkable annual fluctuations in ha, ton and ton/ha.

To make clear the complex relationships in Table 5, the ratios of the maximum to the minimum values during the years were calculated, and are shown in column A of Table 6 in ha, ton and ton/ha. Averages and their standard deviations found during 17 years were calculated, and are shown in column B of Table 6. In addition to these 2 methods, the ratios of standard deviations to their average values were calculated,

| Cassava | | | Sweet potato | | | Peanut | | |
|---|---|---|---|---|---|---|---|---|
| ha | ton | ton/ha | ha | ton | ton/ha | ha | ton | ton/ha |
| 31,910 | 277,180 | 7.12 | 2,254 | 8,246 | 3.66 | 5,927 | 3,455 | 0.58 |
| 31,635 | 267,018 | 8.45 | 4,509 | 16,181 | 3.59 | 7,655 | 2,731 | 0.36 |
| 41,640 | 396,829 | 9.53 | 2,962 | 10,575 | 3.57 | 6,135 | 2,774 | 0.45 |
| 33,493 | 326,883 | 9.76 | 3,309 | 14,218 | 4.30 | 7,427 | 3,512 | 0.47 |
| 13,246 | 108,137 | 8.16 | 3,405 | 11,360 | 3.34 | 3,577 | 3,177 | 0.89 |
| 33,623 | 244,165 | 7.26 | 2,858 | 12,449 | 4.36 | 4,096 | — | — |
| 30,008 | 214,966 | 7.16 | 2,324 | 8,750 | 3.77 | 5,052 | — | — |
| 35,387 | 160,042 | 4.52 | 2,075 | 6,230 | 3.00 | 3,811 | — | — |
| 36,450 | 205,124 | 5.63 | 3,289 | 9,005 | 2.74 | 8,155 | 4,052 | 0.50 |
| 36,450 | 187,897 | 5.15 | 2,070 | 5,085 | 2.46 | 9,571 | 4,150 | 0.43 |
| 33,851 | 168,561 | 4.98 | 1,978 | 5,538 | 2.80 | 10,933 | 4,499 | 0.41 |
| 28,263 | 148,060 | 5.24 | 1,651 | 4,270 | 2.59 | 9,639 | 4,070 | 0.42 |
| 26,807 | 131,875 | 4.92 | 1,566 | 3,598 | 2.30 | 9,256 | 3,383 | 0.37 |
| 25,000 | 99,670 | 3.99 | 884 | 3,393 | 3.84 | 7,153 | 3,152 | 0.44 |
| 26,050 | 155,765 | 5.98 | 2,030 | 4,269 | 2.10 | 13,522 | 6,299 | 0.47 |
| 32,880 | 182,290 | 5.54 | 1,342 | 4,609 | 3.43 | 8,391 | 3,605 | 0.43 |
| 27,193 | 167,854 | 6.17 | 753 | 4,593 | 6.10 | 6,683 | 2,981 | 0.45 |

Table 6. Rearranged data cited from Table 5. A ; ratios of the maximum to the minimum values, B ; average and their standard deviations, C ; ratios of standard deviations to their average values

| | | Paddy rice | Upland rice | Maize | Cassava | Sweet potato | Peanut |
|---|---|---|---|---|---|---|---|
| A | ha | 1.41 | 2.64 | 1.75 | 3.14 | 5.99 | 3.78 |
| | ton | 2.30 | 3.30 | 1.89 | 3.98 | 4.77 | 2.27 |
| | ton/ha | 2.35 | 3.48 | 2.28 | 2.39 | 2.90 | 2.47 |
| B | ha | 15,950 ± 1,653 | 1,453 ± 391 | 30,318 ± 16,809 | 30,817 ± 6,105 | 2,309 ± 952 | 7,470 ± 2,578 |
| | ton | 48,873 ± 12,990 | 2,567 ± 994 | 68,895 ± 12,502 | 202,489 ± 76,414 | 7,786 ± 3,861 | 3,703 ± 884 |
| | ton/ha | 3.03 ± 0.63 | 1.72 ± 0.45 | 0.54 ± 0.10 | 6.45 ± 1.68 | 3.41 ± 0.94 | 0.48 ± 0.13 |
| C | ha | 0.10 | 0.27 | 0.13 | 0.20 | 0.41 | 0.35 |
| | ton | 0.27 | 0.39 | 0.18 | 0.38 | 0.50 | 0.24 |
| | ton/ha | 0.21 | 0.26 | 0.19 | 0.26 | 0.27 | 0.26 |

and are shown in column C of Table 6.

The following facts can be seen from the data obtained in Tables 5 and 6. Paddy rice and maize are constantly cultivated in comparison with other crop kinds, and showed relatively small fluctuations. In other words, farmers attached importance to paddy rice and maize. On the other hand, upland rice showed relatively large fluctuations. In other words, upland rice was strongly influenced by several environmental conditions, especially rainfall in the respective periods. Sweet potato showed the largest fluctuations of the 6 crop kinds compared. Similar tendencies were ascertained also in ton and ton/ha. Owing to these facts, farmers placed dependence primarily upon paddy rice and maize for a long time.

It does not necessarily follow that the patterns of annual fluctuations of the respective crop kinds change in the same way. However, it can be said that fluctuation with the passage of time and year of paddy rice were similar to some extent in Bangkalan and Sumenep, Pamekasan and Sampang.

### 3. Extensive considerations on rice cultivations

For discussion of rice cultivation in these areas, the following categories were adopted, using the data obtained from observations and hearings, *i.e.*, problems of strains used and changes of them, soil and topographical features, reclamation, mixed strains, irrigation status, shifting to other crop kinds and relation between rice and fish cultures.

1. It is said that varieties cultivated in Indonesia are considered to be the advanced ones at the present. However, it was noticed that the strains showing 4 red and 1 black grains were collected during the trip (Table 1). Though these strains are not dominant varieties in the whole of Indonesia in comparison with the white grains, they are carefully and consistently kept by the farmers, and used for boiled rice, alcoholic drinks, confectionery. It is said, sometimes, that the qualities of red and black grains are better than that of the white grains. So, it may be concluded that the cultivation of these strains is a local tradition carried down from generation to generation. In other words, it is intelligence of domestic science.

There is every indication that several primitive varieties are switched to so-called "advanced varieties" or "high yielding varieties" in the world. A green revolution was promoted by the governments designated as BIMAS in Indonesia [11]. These changes being several serious problems to the areas. Firstly, though skillful programs of agricultural practices had been established to avoid serious periods of short supply or off-crop seasons of several primitive varieties, these schemes were broken down by the recent varieties, because of differences of growing habitat and period. Secondly, ear plucking by *ANI-ANI* or *PUGUT* became difficult, because advanced varieties, for example, IR32, IR36 introduced from the Philippines in 1978 to 1980, had a tendency of shorter culms than that of the primitive varieties, for example, *GAJJUK, TARKONEN, CEMPA, PURU, TAKAN, PERITA, BENGAWAN.* If these tools were used for advanced varieties, harvesting procedure may be bad for the farmer's health, for example, crick in the back. Thirdly, partially owing to the second reason, grades of productivity or soil fertility made the matter still worse, because residues including straw were eaten by cattle after harvesting ears, and their excrements were restored to the soil in the previous type, but residues were permanently in danger of being taken away. Fourthly, there are economic obstacles to the changing of strains. To keep the sufficient growth and harvest, cultivating practices are requested for preparing fertilizer, insecticides, fungicides, herbicides, adequate water control, and cautious management. To establish these schemes, the author would like to emphasize the necessity for exhaustive training and subsidy to the farmers by the government.

Fifthly, the people are fonded of the taste of the local varieties than that of the advanced varieties. Farmers planted advanced varieties in large areas for sale and local varieties in small scale for themselves. So, consumers could not get good rice for taste.

It was concluded that rice strains were extensively changed to some grade by the green revolution. Though the major strains were clearly changed, the minor strains were not changed and but firmly remained. In other words, there is every indication not only in Indonesia, but also in the world that farmers were against it, whatever others may say.

2. Rice cultivations will be discussed in relation to soil and topographical features. Rice plants were cultivated not only in mature fields but also in poor localities, growing sporadically, in heavy swampy area (for example, Terenggi), waste land (Kalanget), sandy land (Ambunten), lower edge of sandy slope (Jatirogo), and others. They were looked upon as "cultivating status" in everywhere. It was noticeable that paddy rice was cultivated also in the dry land, in which upland rice was fundamentally used in several places of southeast and south Asian countries. It may be concluded that paddy rice was looked upon as a very important crop kind much more in East Java than other Asian countries.

In semi-waste land having readjustment of arable land near it, selection of varieties was done in accordance with land conditions as follows (near Socah); road → waste land (not planted) → semi-waste or swampy land (local varieties) → readjustment (advanced varieties). In these cases, local varieties were found on the road side but not found in central areas. In other words, farmers suit varieties to each place owing their respective suitabilities.

3. Waste land, growing only weed, such as *ALANG-ALANG* (*Imperata cylindrica*

BEAUV.) grass, or not planted, was reclaimed as arable lands by the constant efforts of farmers and/or the government. It was noteworthy as a good reclamation-techniques that the broad waste lands east of Kwanyar were regenerated as arable land. This land had been looked upon as unproductive area in the past, but was changed into arable land. It was dug in and systematically heaped up in some sections. The lower parts have about 80 cm depth in average under the upper parts and were used as paddy field, and the upper parts were used as upland field. Now, these areas consist of broad paddy field with rectangular upland field.

Rice in the lower parts showed considerable harvest. Shallow or semi-shallow water varieties were used in these areas. Upper parts were protected surrounding paddy field and water, in which banana, cassava, pepper, sweet potato were cultivated and showed also considerable harvest.

Waste land near Babat was lacking irrigation water. But, soil was dug out here for making bricks, and naturally it became a rain water tank. It finally became a rainfed paddy field.

Slopes showing more than an 8 degree angle of inclination have a tendency to be reclaimed as agricultural land in everywhere in East Java. In these cases, the slopes were cut and changed to terraces. These areas were used at first as a grazing land for cattles or goats, and then as upland field for crops such as peanut or gram, then for upland rice, and finally as paddy field.

4. Mixed varieties of several types were found in many locations. This system has a long history, in these areas, and has both merits and demerits. As for the merits, some varieties of rice can complete their life cycle, even when some insects or pests occurred seriously or when water conditions were inadequate for growing rice plants. In Terenggi near *TAMBAK*, 6 varieties including red grains (Nos. 8-13 in Table 1) were collected at the same paddy field in heavy swampy areas. As for the demerits, troublesome procedures were necessary to control insect, pest or weed and in harvesting. Products were mixed several types for marketing procedures. Farmers mixed them with full knowledge about the merits and demerits.

5. In view of the average pattern of rainfall during a year, it is said to be possible to cultivate several crop kinds during a year[4]. However, continuous non-rainfall days are worthy of attention, because they fundamentally affect agricultural practices, especially rice cultivation, and are recorded as frequently occurring in these areas. Irrigation systems may work out a solution to these problems[5]. Hydrographic settlement has a long history in these areas (for example, Lenteng, Ambunten), and are under construction in several places at the present (for example, Kedungdung). These settlements have been pushed forward by the government, because products of rice were, in general, recorded as 4-6 ton/ha and 2-3 ton/ha in irrigated and non-irrigated areas, respectively.

Adequate dam systems were found at Lenteng, Ambunten and Bangkalan. The Lenteng dam was used for system both as agricultural and domestic supply. The Ambunten dam is a reservoir to which water is pumped up and stocked. The last one is on a large scale and has a long history. The irrigation system planned in Kedungdung was aimed at having capacity for 2,000 ha and at making possible double paddy cultivation in a year under a 5 year program. However, irrigation systems found at the present were looked upon as not able to fulfil their function and were connected imperfectly with one another. Indeed, overflow water was seen in several places, for

example, Pakoon, Sampang, and others, though agricultural lands near these places had not effective and sufficient water for cultivation. Moreover, irrigation canals burst with strong rainfall, and became muddy streams talking away neighbouring soils.

Even in un-irrigated areas and only rainfed areas, upland rice was cultivated, in general, in the areas having more than 1,000 mm rainfall in a year, as "1-crop 1-year" system.

In areas having no irrigation systems, small ponds had a very important role for cultivation, and were found in several localities, especially slope or mountain areas. In Bungah, many ponds were located around paddy fields. In Waru, they were connected with one another and became adequate reservoirs. Sometimes, a place used for a nursery bed at first became a small pond after transplantation of rice. In these cases, a nursery bed had been created beforehand on level lower than the neighbouring places.

In areas having no irrigation systems and no ponds, draw-well or a cistern was adopted for the cultivation of rice and other crops. The side wall of the well is built up by bricks or only plastered by mud.

6. Rice cultivation suffered some change in some areas at the present, in which paddy field changed to tobacco or sugarcane plantations, and the agricultural systems showed some degree of economic transformation.

7. Rice cultivation in south and southeast Asian countries is often connected with fish culture. Indonesia is no exception. The fish pond system is called *TAMBAK*. Areas cultivating rice and fish are called *SAWAH TAMBAK* as a general term. A sample was found near Lamongan, in which rice was cultivated in a central portion enclosed by vinyl sheet for protection from rats. Milkfish was cultured in the surroundings. The variety having white grain *indica* was used here. These were found in several localities, *i. e.*, Sidiya, Bungah, and others.

Three types of rice and fish double cultivation were found at a place 9 km west from Babat, altogether 26 ha. One type was nearly the same as that of Lamongan but without a vinyl sheet. The central portion cultivating rice was constructed higher than the surrounding areas cultivating milkfish, and about 70 cm lower on average than an embankment where water convolvulus called *KANGKUNG* was growing. The second type was called *MINA PADI*, where surrounding areas were not clearly distinguished, and had only rice cultivation. In these area, fish culture was not separated from rice, and fish such as a carp (Babat) or an eel (Pepanjen) lived together with the rice. This type was found in several places such as Kertosono, and is said to be a popular type in south and southeast Asian countries. The third type is a separated type called *SAWAH* and *TAMBAK*, where rice and fish are cultivated side by side.

Several conditions are necessary for these types. i) Depths of water from 50 cm to 110 cm were measured. ii) Shallow water types of *indica* variety were looked upon as suitable for these conditions. iii) To avoid flood damage, it was seen as impossible to set *SAWAH TAMBAK* in an area, where the water level is much lower than river level. iv) *SAWAH TAMBAK* located at 10 km west from Gresik was operated on one side and but not on the another side. Insufficient water supply may the cause of this phenomena.

## Summary

During the period from June to July in 1981, the writer was sent to Indonesia for research on agricultural practices. The conditions of rice cultivation in East Java, especially in Madura Island, are briefly reported in this paper in 3 parts, *i. e.*, morphological characteristics of rice grain, statistical data and rice cultivation methods. The findings are summarized as follows:

*Morphological characteristics*: Twenty-nine strains collected were divided into two groups, *i.e.*, B type (10.3%) and C type (89.7%). It was noticeable that strains showing 4 red and 1 black grains were found. Though these strains are not the dominant ones in the whole Indonesia in comparison with the white grains, they are carefully and consistently kept by the farmers. This is one of the reservation of history.

Average values of length, ratios of length to width and of length to thickness of East Java were ascertained as larger than that of the whole of Indonesia. Materials collected at *SAWAH TAMBAK* showed the very large intra-population's variations.

*Statistical aspects*: Seven prefectures in East Java were divided into 4 groups based on the cropping systems. Upland and direct sowing methods were seen as representative of Madura prefecture, and rice products had the first share of 12 main crop kinds in 6 prefectures except Madura. There were no fine differences in total rice products between the 4 districts of Madura. However, direct sowing had a larger portion in Sampang district than for the whole of Madura.

In view of the annual fluctuations during 1963 to 1979, paddy rice and maize were said to be constantly cultivated in comparison with other crops, and showed relatively small variations. In other words, farmers attached importance to paddy rice and maize.

*Considerations*: Discussions were extensively made on rice cultivation from the viewpoint of alternation of strains, soil and topographical features, reclamations, mixed strains, irrigation systems, change of crop and the relation of rice and fish cultures. Five serious problmes connected with the change from primitive to advanced strains were extensively discussed. Though the major strains were clearly changed by the green revolution, the minor strains were not changed but were firmly reserved.

It was noteworthy as a reclamation-technique that waste land near Kwanyar was regenerated into arable land, and rice and upland crops were cultivated in lower and upper sections. Hydrographic settlements have a long history in these areas and are under construction in many places. Moreover, in areas having no irrigation systems, small ponds had a very important role for the cultivation not only of rice but also of several upland crop kinds.

Rice cultivation is a often connected with fish culture, and there were 3 main types of combinations. In these areas, some of the characteristics of rice varieties and of techniques were ascertained.


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