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Effective Working Efficiency of Japonica Rice Production in Japan, China and the U.S.

Hideo Higuchi*, Shoichi Ito* and Hajime Kobayashi*

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Production of high quality japonica rices are becoming more popular in many areas of the world reflecting more open markets during recent years. In this study, three countries such as China where the japonica production is the largest in the world, the U.S. which is the most technologically advanced with largest scale per farm, and Japan where production costs are the highest in the world, were compared regarding effective working efficiency. The rice production pattern in China is quite similar to the one in Japan; however, Chinese production heavily depends on manpower as well as horses and cows. The results of this study indicate that effective working efficiency in China may be quite low, even lower than Japan. On the other hand, effective working efficiency in the U.S. appear to be very high. Japan should improve its rice production system by increasing the farm-size to enhance labor productivity in order to compete with imported products.

Introduction

Agriculture in Japan is generally characterized as small scale and inefficient with a diminishing number of young farmers. Land is abandoned in some areas. All of those problems create high-priced products. In 1993, rice in Japan was produced 30 % less than normal due to bad weather, and the government took an emergency measure to import nearly 3 million metric tons (roughrice basis) of rice from Thailand, the U.S., China and Australia. In 1995, Japan partially opened its rice market under the Uruguay Round agreement of the GATT (General Agreement on Tariff and Trade), which reached an accord in 1993.

Japan produces as much as 12 million metric tons of japonica rice, and domestic market prices are extremely high reflecting high production costs. This, however, has

* *Department of Agricultural Information Science, Faculty of Agriculture, Tottori University*

eventually led some prospective countries such as China, the U.S., Thailand, Australia, the Philippines and Spain to produce high quality japonica rices using Japanese varieties such as Koshihikari[2].

In China, where the total area and the population are so huge, rice production accounts for a third of the world total rice production, and japonica rice production has been dramatically increasing across the whole nation. However, the technology is quite behind and their production is heavily based on manpower rendering an extremely low labor productivity in the nation. But retail prices are very low at 3.5 yuan (1 yuan≒13 yen) per 1 kg of milled rice (according to this research as of January 1995) reflecting low labor cost relative to Japan and the U.S.: A daily wage for a simple construction worker is about 30 yuan, and farm wages are substantially lower than this in China.

Because China is spread from north to south with the latitude between north 50 and 20 degrees, climate and soil conditions in some areas such as Heilongjiang and Jilin Provinces are suitable for japonica rice production, and high quality japonica rice from these areas may eventually be exported to Japan.

This study focuses on labor productivity regarding effective working efficiency in Chinese and the U.S. japonica rice production and compares with those in Japan.

Data

Data for Japan were collected from 68 farms in Tottori while data for China were collected from 46 farms in Changchun regarding farm size, soil quality and labor hours for tilling, rice transplanting and harvesting. These surveys were based on questionnaires distributed to rice farmers in those areas. Despite the instruction provided in the questionnaires, there were some minor discrepancies in measuring. However, those errors were minimal and the results should barely affect the evaluation of characteristics in individual countries. Data for the U.S. were collected from three rice farms in Sacramento, California and one in Little Rock, Arkansas. These surveys were conducted during 1990 through 1995. Data on climates in those areas were collected from published source[4,6].

Climate

Figure 1 shows the normal temperature in Changchun, Little Rock and Tottori during 1961 through 1990, Figure 2 relative humidity, and Figure 3 the highest/lowest

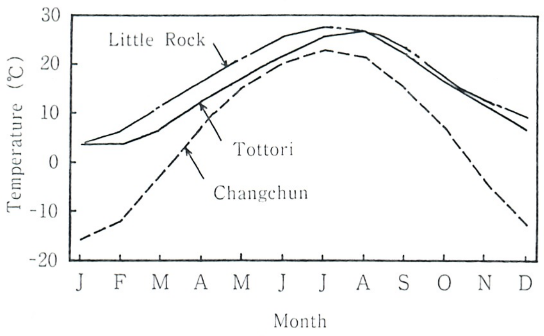

Fig. 1 Normal temperature

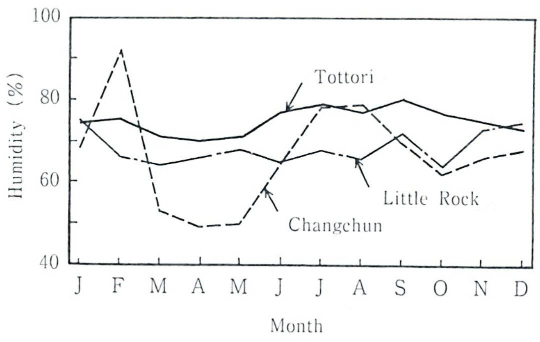

Fig. 2 Relative humidity

temperature in Changchun and Tottori[4). Although there is not much difference in latidudes among the three areas, there are considerable differences in temperature and humidity. Daily differences in temperature in Changchun and Little Rock are much larger than the one in Tottori.

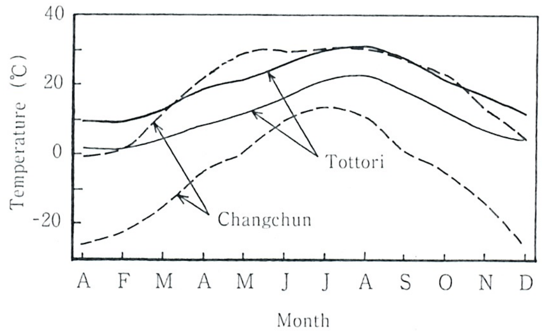

Fig. 3 Highest/lowest temperature

Rice Fields

1. Soil

Figure 4 shows grain size accumulation curves for rice field soils in Tottori, Changchun and Little Rock, while Table 1 describes the soil consistency and cation exchange capacity as well as their standard deviations in each farm. There were no statistically significant differences in those items among the three areas.

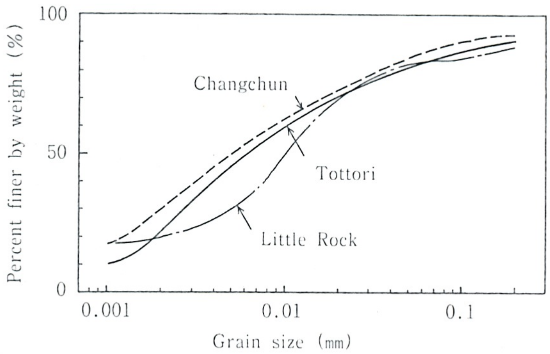

Fig. 4 Grain-size accumulation curve of field soil

2. Farm size

Average farm sizes in Tottori, Changchun and Little Rock are 0.6 hectares (ha), 1 ha and 100 ha, respectively. While the sizes between Changchun and Tottori are small, the one in Little Rock is quite large, large enough to facilitate operations using the large machines.

There were no published data on size of each rice field in Tottori, Changchun and

Table 1 Atterberg limit and cation exchange capacity of tested field soil

Soil sample		Real specific gravity (g/100c.c.)	Liquid limit (%)	Plastic limit (%)	Cation exchange capacity (ml/100g)
Tottori	Mean	248	43.32	27.03	16.3
	S.D.	4.5	1.42	0.39	0.36
Changchun	Mean	268	49.31	29.62	23.7
	S.D.	5.2	1.86	0.71	1.2
Little Rock	Mean	259	46.45	28.46	20.1
	S.D.	2.1	2.12	0.52	1.6

S.D.: Standard deviation

Little Rock; therefore, they were surveyed in this research. Figure 5 shows the results. Selections of fields were based on a ratio of location in the two categories; hilly vs. flat/delta areas. Rice fields in Changchun are situated in more flat/ delta areas relative to the counterparts in Tottori.

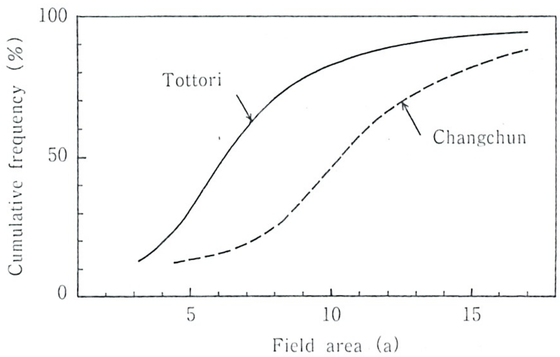

Fig. 5 Cumulative distribution curve of field area

Fields for indica rice, in particular, in China are mostly located in the flat areas, while japonica rice fields in the flat and hilly areas account for 84 % and 13 %, respectively. Contrary to Japan, there are no rice fields observed in the mountainous areas in Changchun. Farm-roads and levies in the rice producing areas in China are not well constructed. Meanwhile, the average size of rice fields on the Isbell Farm in Little Rock is 1.3 ha, which is about 10 times as large as that in Tottori.

Labor Hour

Table 2 reports the average labor hours invested in japonica rice production in Japan (national average) and Tottori (provincial average) surveyed by the Ministry of Agriculture, Forestry, and Fisheries of Japan (MAFF)[6]. The table also shows the averages in Tottori (Tottori-A), Changchun, and California /Arkansas in the U.S. surveyed in this research. Out of 68 rice farms surveyed in Tottori, 29 of them are located in

Table 2 Labor hour

(h/ha/10)

Country	Japan Whole C.	Japan Tottori	Japan Tottori-A	Japan Tottori-F	Japan Tottori-M	China	U.S.
Seed treatment	0.4	0.6	0.5	0.4	0.6	0.5	0.2
Nursery bed	4.5	3.7	4.2	3.6	5.3	8.2	
Tilling·Leveling	5.5	4.9	3.5	3.0	7.0	9.1	0.6
Basal application	1.4	1.7	1.6	1.5	2.9	3.2	0.1
Direct seeding							0.1
Transplanting	5.8	4.2	2.2	1.7	5.2	22.8	
Additional manure	1.2	1.1	1.0	0.9	2.0	2.1	0.1
Weeding	1.9	1.7	1.4	0.7	3.4	5.6	0.1
Watering·Drainage	7.4	6.2	5.8	4.2	6.3	10.9	0.3
Pest control	1.5	0.8	1.4	0.5	1.9	2.5	0.1
Harvesting·Threshing	6.7	8.3	4.9	3.2	12.8	15.8	0.4
Transportation							0.2
Drying·Hulling	2.3	2.9	2.4	2.3	3.6	22.6	1.0
Production control	1.0	1.5	1.0	1.1	1.4	1.5	0.2
Total	39.6	37.6	29.9	23.1	52.4	104.8	3.4

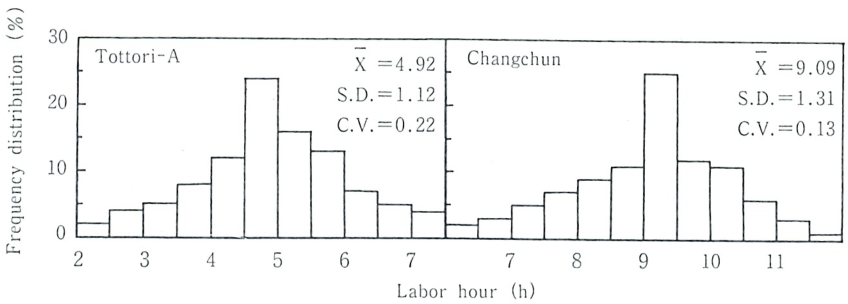

Fig. 6 Frequency distribution of labor hour for tilling

the flat/delta areas (Tottori-F) and 18 in mountainous areas (Tottori-M), and the average size of fields in the flat/delta areas is 0.097 ha and in the mountainous areas 0.039 ha. There is a big difference in the figures between data reported by the MAFF and by this research. The differences are more prominent in labor hours used for tilling, transplanting and harvesting. A production process in China depends heavily on cow/horse-power for tilling and smoothing of the fields and on manpower for transplanting and harvesting; this is similar to the type exercised in Japan about 30 years ago. Labor hours engaged in rice production in the U.S. are very small, about one-tenth of Japan indicating that mechanization is well advanced in the U.S. rice production.

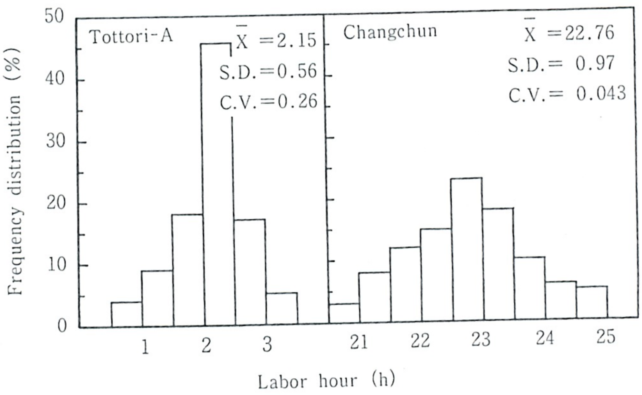

Fig. 7 Frequency distribution of labor hour for transplanting

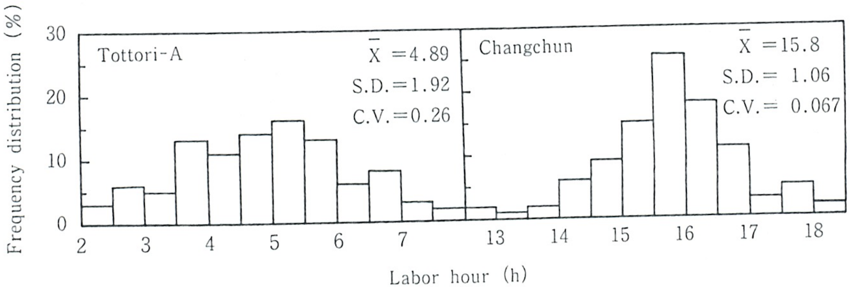

Fig. 8 Frequency distribution of labor hour for harvesting

In rice production, tilling, transplanting, water management and harvesting are engaged with manpower. Figure 6 shows Frequency distribution of labor hours for tilling in Tottori and Changchun, surveyed in research, while figures 7 and 8 show frequency distribution of labor hour for transplanting and harvesting, respectively.

Effective Working Efficiency

Large-scale operation is a key to reduction of production costs. In this research, the statistical relationship between farm-size and costs of production was estimated using a simulation process which was once employed by Togashi et al[1,3,5]. However, coefficients for equations were estimated in this research. Effective working efficiency was measured and calculated by equations as follows:

$E = C/Ce \times 100$ where, E = effective working efficiency

$C = 60 \times A/T$ A = practical working areas in are

$Ce = 36 \times W \times V$ T = working time in minute

W = effective working width in meter

V = effective working speed in meter per second

Figure 9 shows relationship between field scale and effective working efficiency for tilling in Tottori, Changchun and Little Rock. In this investigation, three different types of tilling machines were used; MT205 (made by M company) with an operating width of 1.4 meters and a speed of 0.36 meters per second in Tottori, Type KY (made by C company) with a width of 0.7 meters and a speed of 0.25 meters per second in Changchun, and F-5100 (made by F company) with a width of 2.4 meters and a speed of 1.6 meters per second in Little Rock. The results in this research are somewhat different from those obtained by Togashi et al. However, the finding of this research, that the larger the scale of field, the greater the value of effective working efficiency, is in line with the results by Togashi et al. The level of effective working efficiency in Changchun was smaller than in Tottori. The difference may be dependent on shapes of individual fields and size of machines.

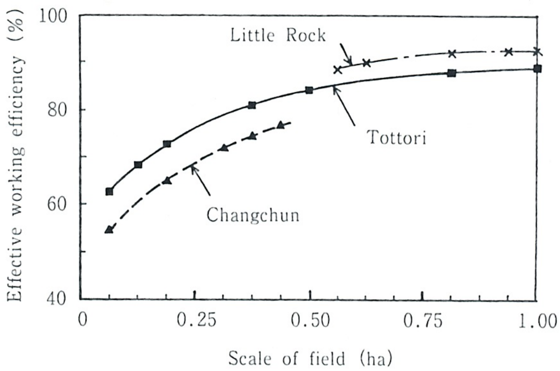

Fig. 9 Relationship between field scale and effective working efficiency for tilling

Conclusion

This research was conducted to compare the costs of japonica rice production in Japan, China and the U.S. The costs were examined based on labor hours engaged in overall japonica rice production and on effective working efficiency. The Chinese production process is quite similar to the Japanese, but China is more manpower oriented with a smaller level of effective working efficiency than Japan. Comparing with the U.S. situation, however, Japanese rice production is still involved with an enormous amount of labor costs and, thus, a smaller level of effective working efficiency. About one third of the total production costs is accounted for by labor in Japan while in China and the U.S. the counterparts are one sixth and one tenth, respectively.

As indicated in Table 2, major labor is engaged with nursery/transplanting, water management, and harvesting in Japan and China. In Japan, nursery and transplanting, water management, and harvesting account for 26%, 19% and 17 %, respectively, of total labor hours in japonica rice production; a sharp contrast with the situation in the U.S.

It is well known that labor costs account for the major portion of the costs across all types of industries in Japan. Accordingly, more and more Japanese companies have shifted their operation to other nations during recent years, and this appears to cause increases in domestic unemployment problems. In Japan, high labor costs are indeed a problem for agriculture as well. A possible solution to these high labor costs of japonica rice production in Japan would be eliminaiton of transplanting system and adopting direct-planting system which has been applied in the U.S. for some time. Another would be adoption of computerized/mechanized system for water management, in which farmers would control water levels in the paddy fields at the control facility center rather than manually conducting at individual fields.

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