Contribution of Newly Developed Varieties to the Increased Production of Rice in The Warm Districts of Japan……a case of Hoyoku, etc.……

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In the last few years, rice production has steadily been increasing in the northern part of Kyushu, the southernmost island of Japan. The highlight of this increase is Saga Prefecture's total average yield of 5.12t and 5.42t of brown rice per hectare, when Saga ranked first among the 46 prefectures throughout Japan in the last two years of 1965 and 1966.

Although rice production is governed by many complicated factors, and only their harmonious interactions result in high yields, the current increasing trend in rice production in Northern Kyushu is believed to be derived basically from the rapid distribution of the newly developed rice varieties, such as Hoyoku and others. These varieties are considered to be of quite a new type, and have enabled Northern Kyushu to take an upward turn in rice production.

The solution for the standstill in production was one of the important problems to be tackled, but without much success until several years ago when the new varieties were developed.

When we review yearly average yields of each of all the prefectures in the past about 100-year period, the most prominent feature is that the high yielding area has completely shifted from the Southwestern areas to the Northeastern districts of Tohoku and Hokuriku.

In earlier years, the Southwestern areas were far advanced in rice production, as compared with the colder areas. With the shifting from organic fertilizers to chemical ones, the warm areas have come to suffer

Table 1. Average rice yield (t/ha), and number of effective panicles and grains per m² in five years periods of 1956 to 1960, and 1961 to 1966, for each of 9 districts of Japan.

	Brown rice yields(t/ha)		Effective panicles per m²		Number of Grains per m²	
	1956–'60	1961–'66	1956–'60	1961–'66	1956–'60	1961–'66
Whole Japan	3.77	3.96	304	317	23,740	24,840
Hokkaido	3.40	3.54	366	399	23,980	27,320
Tohoku	4.26	4.49	361	355	26,280	27,100
Hokuriku	4.04	4.34	324	338	24,900	26,080
Kanto-tozan	3.77	4.02	295	316	25,460	26,280
Tokai	3.40	3.41	261	263	21,040	21,900
Kinki	3.70	3.65	271	278	21,760	22,640
Chugoku	3.55	3.74	276	285	21,860	22,060
Shikoku	3.57	3.57	272	278	22,400	23,040
Kyushu	3.57	3.86	276	298	22,120	23,640

Japan consists of four major islands: Hokkaido isl. in the north, Honshu isl. that includes Tohoku, Hokuriku, Kanto-tozan, Tokai, Kinki and Chugoku districts in the middle, Shikoku isl. in the south-east and Kyushu isl. in the south.

Usually North-eastern Japan includes 3 districts of Tohoku, Hokuriku and Kanto-tozan, South-western Japan 5 districts from Tokai to Kyushu.

Akiochi or other inferior cultural conditions, due to soil and climatic defects or biological hazards, which all contributed to slowing down the effect of efforts to increase rice production.

The cold areas attained a high level of production in recent years, and it seemed extremely hard for the warm areas to catch up with the cold areas.

Generally speaking, rice plants grown in warmer areas of this country have smaller number of panicles and grains per m^2., as well as smaller grain/straw ratio, when compared with plants grown in colder areas (Table. 1)

However, it seems extremely hard to explain such an overall or general trend, unless it is considered to be due to specific soil or climatic conditions of the area in combination with peculiarities of the rice varieties generally grown there.

Japanese farmers, because of their relatively small land holdings, are always making their utmost effort to coax their limited land areas of paddy fields to yield as much rice as possible, supplying much fertilizer and labor. They try closer plantings and put much fertilizer per unit area, with the hope of securing higher yield components, [number of ears and grains per m^2], all aimed at higher rice crop returns. But as it is often the case, if there resulted in a bad lodging, or over-vegetative growth followed by checked growth in the subsequent reproductive or ripening stage, the farmer would be unable to obtain the high yield they desire. Therefore they are required, instead of increasing merely the amount of fertilizers, to make deliberate determinations on the optimum amount and suitable methods of application for fertilizers, on the desirable rate of transplanting density per unit area, and all other cultural practices. Very skilled farmers often would grow rice plants to optimum size or just to the peak before plant size causes falling and lodging and a failure to fill grain. But generally there is always a boundary limit set for the average farmers' get-more-rice effort.

A few of the experimental data would better explain this: In order to obtain a higher yield of rice, it seems to be imperative to get enough plant growth for the desired yield, so far as it does not badly affect grain production.

Fig. 1 Grain-straw relation in Norin 18 variety.

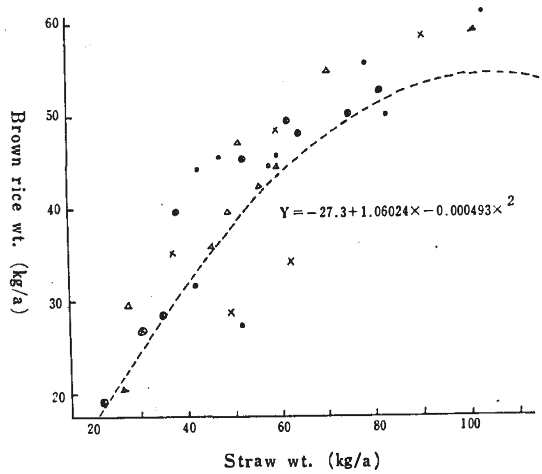


Fig. 1 and Fig. 2 give the inter-relation between grain yields and straw weight for Norin 18 and Hoyoku varieties. These were prepared by using many experimental data obtaind at Kyushu Agr. Exp. Station, during the period from 1958 to 1965. A noteworthy fact is that Norin 18 gave increased yield of brown rice with the increase of straw weight up to 80 kg/a, but above that point there was no appreciable increase in yield (Fig. 1). Dr. Murayama also examined the same yield-straw relation from a number of experimental data obtaind at many experimental stations all over Japan, and pointed out the yield slowed down at about 80 kg/a of straw weight. At this point, however, no exact answer is available about what this 80 kg/a means. Here we should notice the fact that though we may try to make dense planting and use much fertilizer with the expectation of obtaining higher yield of rice, this will eventually lead to the overgrowth of plant body, which aggravates the mutual shading, retards growth during the period from heading to ripening, causes lodging of various degrees, and all these will nullify the farmers' effort. Besides, as has already been pointed out, in warm areas, the rice plant has relatively a low value of grain/straw ratio. In warm areas, the important thing is how to make the rice plant have larger straw weight growth without an adverse effect on grain yield, and at the same time get a higher grain/straw ratio.

Until several years ago, in Northern Kyushu, Norin 18 was the leading variety, and was also one of the major varieties throughout this country, mainly distributed in South-western Japan, occupying nearly 163,000 hectares. This fact indicates that the variety was once a most satisfactory rice variety for the farmers. However, since farmers always want bigger yields year after year, the popularity of this once a great variety was gradually fading away, since it often suffered bad lodging with the increasing trend in the amount of fertilizer applied by farmers. In other words, farmers were gradually learning the limitation of Norin 18 under the cultural conditions of the warm areas.

On the other hand, Fig. 2 shows the grain/straw relation for Hoyoku variety. Here this variety gives quite a different result. The brown rice yield increases with the straw weight, almost in a straight line, even in the range of straw weight over 80 kg/a. This indicates that the variety can endure much

Fig. 2 Grain-straw relation in Hoyoku variety.

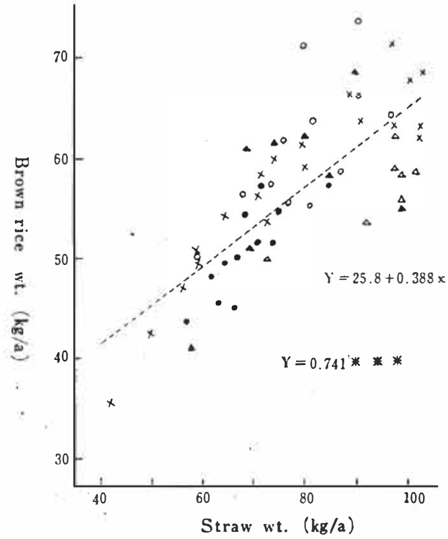
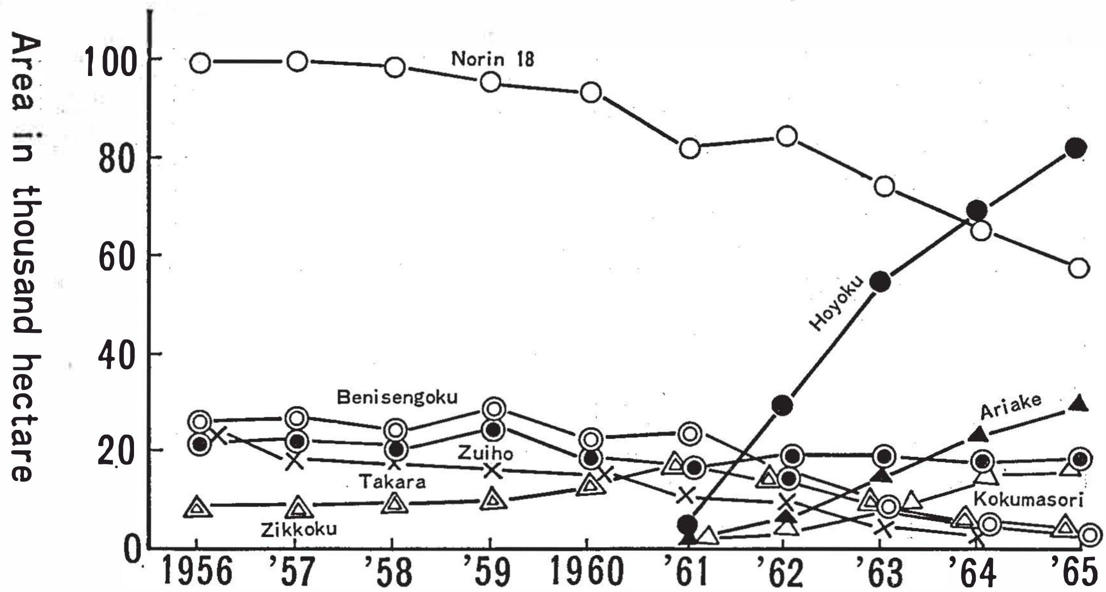


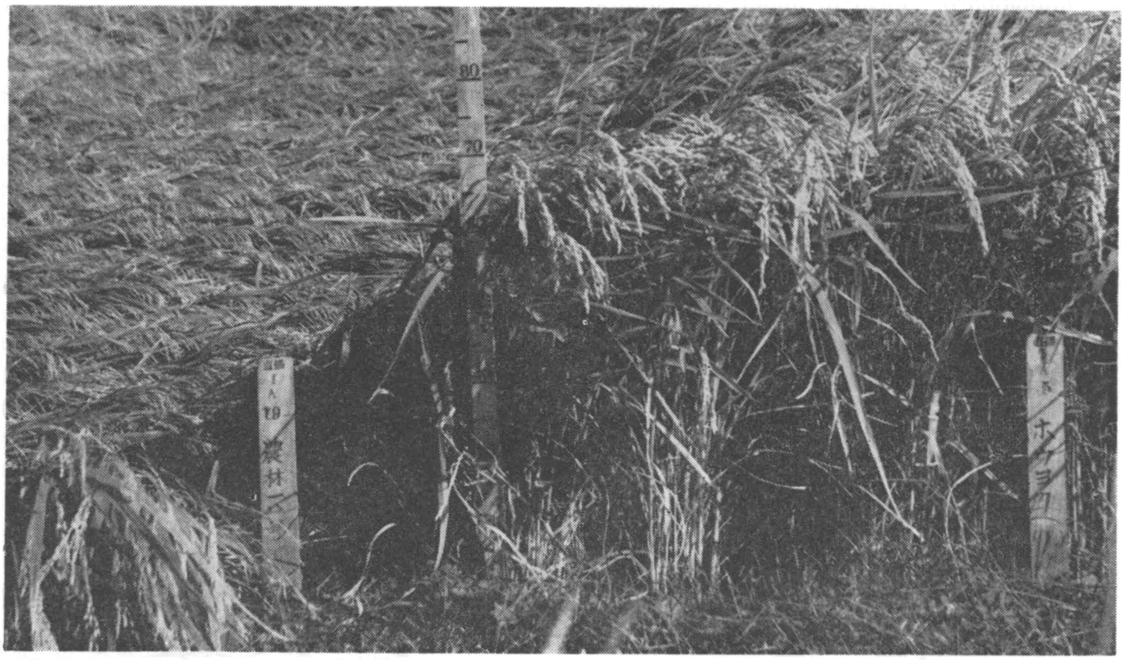
Fig. 3 Change of rice varieties in Kyushu district during period from 1956 to 1965.



more dence planting and higher fertilization than Norin 18. This is considered to be the explanation of the high yielding potentials of Hoyoku and other similar varieties.

Hoyoku was developed at Kyushu Agr. Exp. Station, and first released in 1961. It was followed by its sister variety Kokumasari in 1962. These varieties were distributed with unprecedented speed to the most fertile paddy field areas along the coastal region of Ariake Bay in Northern Kyushu. Fig. 3 represents the change of main varieties in the whole Kyushu district during the past 10 years. In the past 4 years, Hoyoku has gained rapidly and now occupies over 80,000 hectares, replacing Norin 18 and other varieties. The replacement is more pronounced in Saga and Fukuoka prefectures, where Hoyoku is mainly distributed today.

Probably this expansion of new varieties is due to their high yeilding potentials. Table 2 gives the actual yield averages (t/ha) for Hoyoku, Kokumasari and Norin 18 in Saga Prefecture in 1964 and 1965, the data being obtained from several hundred sampling plots on farmers' fields. Those varieties have extremely short stems and high resistance to lodging. In a vast stretches of Chikugo and Saga paddy field areas, where more than 70 to 80 per cent of the fields are now planted to these short stemmed new varieties, it is almost impossible to see even a single field badly lodged. Table 3 gives the areas of lodged fields in ha· and in percentage of the total paddy field area, and yearly estimated loss (t), in Saga Prefecture during the past 11year period. We can see that there has been a consecutive decrease in lodged field areas since 1961, the 1st year of Hoyoku's release. Also Hoyoku has a paddy/straw ratio of 1:1, which is nearly equal to the varieties grown in Tohoku areas, and which had not been achieved before by any of the varieties grown in the warm areas. Because of short and erect type of growth of these varieties, they can endure rather dense rate of transplanting



Norin 18 Hoyoku

Lodging resistance test
between Hoyoku and Norin 18.

Fig. 4 - (1) Average rice yield (t/ha) and percentage area planted to short stemmed new varieties in Saga Prefecture.

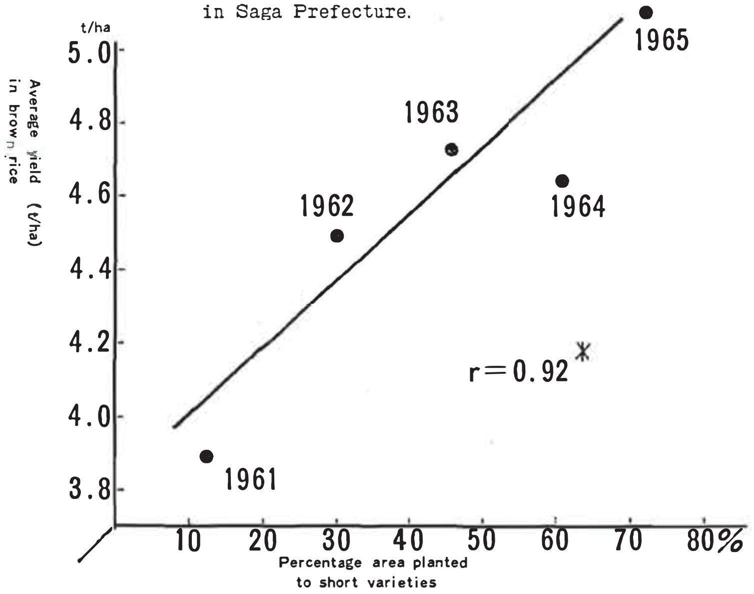


Fig. 4 - (2) Fukuoka Prefecture

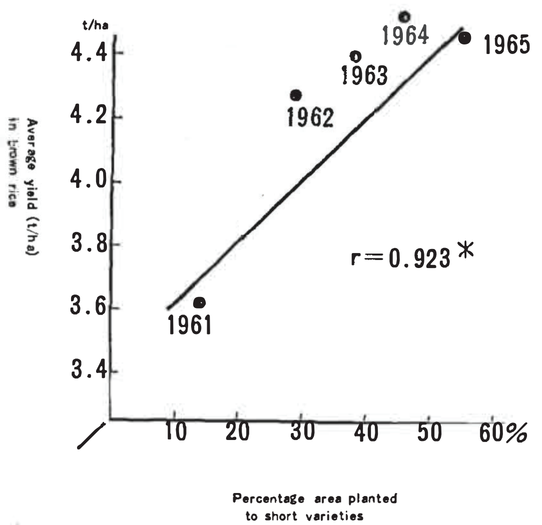
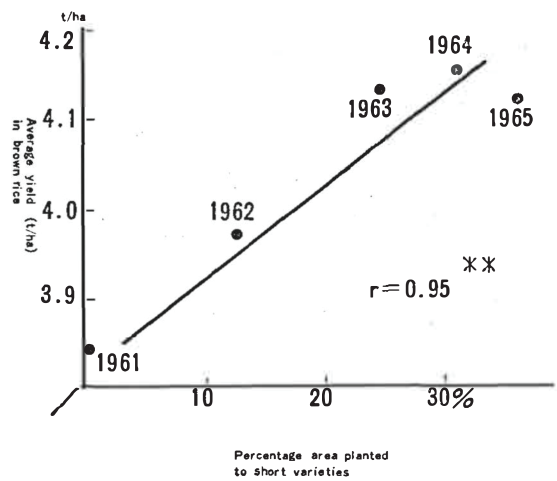


Fig. 4-(3) Kumamoto Prefecture



per m^2, enabling them to bear many more panicles and grains per unit area. The color of the plant leaves at ripening stage is especially attractive, which might be considered to be an indication of the better and healthy physiological condition of the plant leaves and roots in the ripening stage. Also the new varieties show a greater fertilizer response than Norin 18. As shown in fertilizer recommendations for Saga prefecture, these short stemmed varieties are given nearly 30 % more fertilizer elements (Table 4).

Table 2. Performance of new varieties in Saga Prefecture in 1964 and 1965. (Average yield of several hundred sampling plots on farmers' fields)

Years	Brown rice yield in t/ha.					
	Hoyoku		Kokumasari		Norin 18	
1964	4.87t	132%	5.06t	137%	3.70t	100%
1965	5.44	130	5.64	135	4.18	100
Average		131		136		100

Table 3. Lodged paddy fields (ha) and estimated loss (t) in Saga Prefecture during the period from 1955 to 1965.

Years	Lodged area		Loss	
	ha.	%	t	
1955	33,100	63.2	7,860	
1956	7,900	15.0	1,520	
1957	–	–	–	
1958	16,200	29.4	2,450	
1959	20,200	36.7	3,630	
1960	2,860	5.2	442	
1961	30,000	55.5	12,100	Hoyoku released
1962	7,610	13.8	1,080	Kokumasari released
1963	582	1.1	91	
1964	2,410	4.4	423	
1965	15	0	4	

Table 4. Fertilizer Recommendation for paddy fields on flat areas in Saga Prefecture

Varieties	Expected yield (t/ha)	Fertilizer elements (kg/ha)		
		N	P	K
Medium & long varieties	5.1 — 5.4	75–85	50	70–75
Short varieties Hoyoku, Kokumasari, etc.	5.6 — 6.0	100–120	60–70	80–110

These characteristics probably may have reflected on their rapid distribution and replacement of the old varieties, and also may explain their outstanding productivity and the ease with which they are grown. Vast field areas of Saga Prefecture are now planted almost completely to these short stemmed new varieties, and Saga Prefecture is now zooming upward as a leading rice producing locality.

Another noteworthy feature of these new varieties is that they have greatly promoted farmers' willingness in growing rice. Figs. 4-(1), (2), (3) indicate close relation of the prefectural average yield increase and the distribution percentage of short stemmed varieties in Saga, Fukuoka and Kumamoto prefectures, respectively. No doubt such an actual yield increase by the use of these varieties stimulated farmers' interest in rice production.

The Saga Prefectural Government was alert enough to advocate cooperative group activities in growing rice with improved methods and power machines, etc. The modes of these activities were by no means uniform, but they varied within a wide range from rather simple and elementary to the higher and advanced. However in all of them the first step was always the unification of the varieties to be grown that were best fitted to each of the localities. The farmers' organizations and the Prefectural Government jointly supported and promoted the movement with every conceivable means, with hearty cooperation. Activities of the people from technical circles and from the extension service to prefectural government, experimental station, etc. were quite eye-catching. All people concerned united for the promotion of rice production. Such an impressive overall "grow more rice" movement seemed to have come basically from the productive potentials of the new varieties.

The time will come, however, when Hoyoku and other new varieties will become obsolete, and be unable to meet the farmers' requirements, because the farmers' requirements would be rapidly changing, and the new varieties here introduced are by no means perfect. Breeding more new varieties better fitted for the future demands is the role to be played by the rice plant breeders. Thus, breeding new and better varieties are the old and yet the new problem, always awaiting solution.

Tropical Paddy Soils

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Most of the readers of this paper would generously admit that researches in the nutrition of the rice plant and in the fertility of the paddy soil are somewhat more advanced in Japan than in other countries. However, Japonica type varieties grown in Japan and their environmental conditions, such as soils and climates, are all considerably different from those in the tropics. This fact would suggest knowledge, experience and methodology of Japanese specialists might not be directly applicable to improvement in rice productivity in the tropics without conducting much research work on the tropical rice culture.

In 1963 the author and his group initiated a systematic study of the paddy soils in Southeast Asia and have so far covered the larger part of Thailand, Malaysia, and Ceylon and a very small part of Cambodia and the Philippines. Using field observations and the analytical results as a basis, the author attempts here to clarify certain features of the tropical rice soil in comparison with those of Japanese rice soil.

I From field observation.

a) Characteristics in the soil profile.

One of the questions most frequently met by the author in Southeast Asia is that why