Rice Harvesting Machine in Japan

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Harvesting mechanization in Japan

As harvesting machines, small binder and small combine are popular and have been widely distributed in Japan. The former cuts and makes a small bundle of crops while the latter not only harvests, but also threshes simultaneously.

In Europe and the United States, these large size machines have been extensively used in the past 100 years and have shown high performance in the vast stretch of upland. As regards a large binder, the size of a bundle is rather big, its circumference being 1.5 to 2.0 m.

The large binder does not give high efficiency, however, to the lodged plants or at paddy fields where soil pan is not hard enough to support this machine. Due to the impracticable paddy field, it is not suitable for utilization in Japan.

The self-propelled large combine was put into the production line about 30 years ago and has been introduced to give better performance. More than 2 million units were distributed throughout the world, and about 400 units of large combine were imported into Japan from 1962 to 1968. These imported ones are called Direct-flow type combines for the convenience of distinguishing them from the small ones made in Japan. Its cutter bar width ranges from 2 to 5 meters. Anyway, it's a huge machine for small Japanese paddy fields. Researchers and others concerned have exerted their utmost efforts to utilize this giant machine at paddy fields there, while scrutinizing its suitability to the field condition of the planting area for paddy rice totalling 3 million ha. However, the farmer is not willing to use the large combine because it causes grain losses and damage to crops. In addition, a small plot offers another obstacle for further utilization of the combine which is not suitable in such a place for farmers themselves do not like their field to be destroyed by a giant machine. Due to the above mentioned reasons, Direct-flow type combines are shunned by the farmers.

The economy of Japan has been greatly expanding so there has been a noticeable population drain from the rural to urban areas. Consequently, labor shortage in rural districts has become acute. To counteract such a serious condition, mechanized farming is an urgent problem facing the farmers.

The acute depletion of rural population was unavoidable. However the decrease in the number of farm hands was only fractional. Due to this fact, what the farmer wanted most or the aim of mechanization lies not in the higher capacity of the machines but in accuracy of work. The majority of the harvesting machines they need are therefore, of the small type, mini-combine or small binder with the length of the cutter bar ranging from 0.5 m to 1.0 m.

Small bundle binder

Harvesting and after-harvesting work of paddy rice traditionally consists of harvesting rice plants with sickle, making smaller rice bundles and drying them in the sun. This is followed by threshing and drying the threshed grains in the grain driers. The dried grains are fed to the huller and the hulled rice or brown rice is sold to the Government.

More than 80 per cent of farmers raising rice in Japan follows this process. So what a Japanese farmer needs most is to see that the conventional process is maintained. It is the binder for smaller bundle size and the circumference is from 20 to 30 cm.

Regarding the knotting of twine, we have different ways of twisting and knotting the string. We considered and tried various ways but could not find out an easy way for knotting in spite of the efforts to devise the apparatus which became complicated further. Principally, we adopted the binding method of the Knotter Bill system, which was invented around 1880.

As for twine materials, jute, sisal and polypropylene are selected. The binder adopting this knotting system was highly acclaimed on the market recently.

It is estimated that more than 150,000 sets of binder will be put on the market this year. So rapid was the increase of sales witnessed in the span of short years that 1,000 set were sold in 1966, 10,000 in 1967 and 80,000 in 1968. We call this type of binder a small bundle binder against foreign-make large ones.

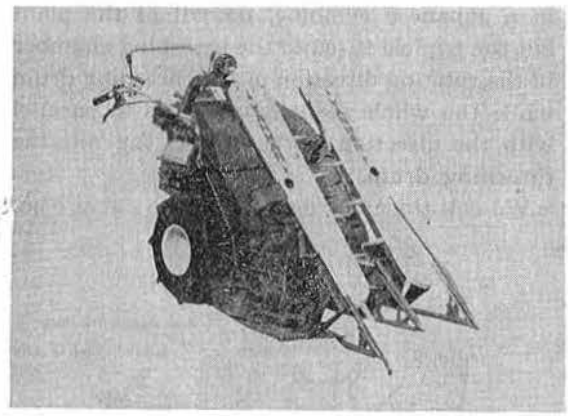

Fig. 1. 2 rows type small bundle binder

Construction of small bundle binder

The construction of a small binder is made up of a pick-up device with fingered chain for the lodged plants 50 mm pitched cutter bar ranging from 30 cm to 75 cm in width, conveying apparatus of stems, binding mechanism and travelling parts.

Concerning travelling parts, a pair of pneumatic tyre is fixed at the rear portion of the cutting device. The binder is a walking-type machine travelling within a range of 0.3—0.8 m/s. Travelling speed on the road becomes a little faster 1.3—1.8 m/s.

The knife bar has 50 mm knife sections and the majority of its stroke is 50 mm.

Dividers are set in front of the cutter bar every 20 or 30 cm of the cutter width. As for the frontal processing apparatus which has dual function, picking up the lodged plants and supporting the upper portion of plants when they are cut, it is fixed behind the

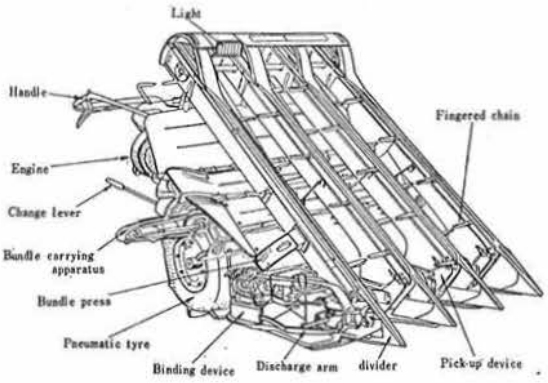

Fig. 2. 3 rows small bundle binder

divider with a certain angle. This apparatus is a pick-up device with the chain, fingered by nylon tines.

Plants, being lifted by the pick-up device, are cut by the cutter bar and forwarded to the conveyor and conveyed to the side or rear portion of the binder. In case of conveying the plant stems sideward, they are shot as far as the binding apparatus by the star wheel installed behind the pick-up device and that of fingered chain or belt for conveying stems sideward. In the latter case, plants are also carried to the binding apparatus of the machine by the star-wheel or that of a crank wheel and chain.

When plants, transported and gathered in a pocket, reach a given volume enough to make a small bundle, press the clutch door with the aid of a packer arm; then the binding

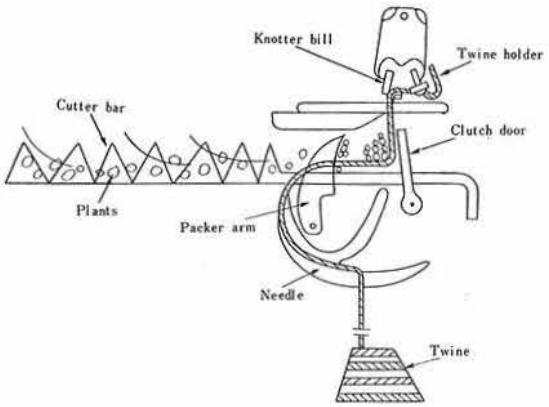

Fig. 3. Binding apparatus

mechanism is put in motion which requires 0.2—0.3 seconds, and the discharge arm throws out the bundle to one side of the binder. Some 1,500 to 1,800 bundles are made up per 10 a.

Concerning this type of binder, those equipped with a 50 cm cutter bar are distributed most popularly.

Operation of binder

The small bundle binder also gives good performance even in harvesting lodged rice or wheat whose standing angle is 20—30 degrees. The grain loss is minimized below 2 per cent. However accurate work becomes aggravated when the standing angle drops as low as 20 degrees or below, and in proportional to the worse condition of lodging, grain losses increase.

When one cuts the plants along the levee as well as at the space where the binder is turned beforehand by the sickles, high efficiency of work is expected, 6—13 a/hr. However, it is not good for harvesting wheat if the fields are ridged.

The size of the bundle is also adjustable to a certain extent within the range of 1.2—1.6 kg.

The mean required horsepower for the binding apparatus is something like 0.7—0.9 PS, 1.0—1.2 PS is also required for cutting and pick up units and 1.0—1.5 PS for travelling section.

Thus, the total required horsepower for binders with a 50 cm cutter bar ranges from 2.5—3.5 PS.

Japanese-type combine, Jidatsu Combine

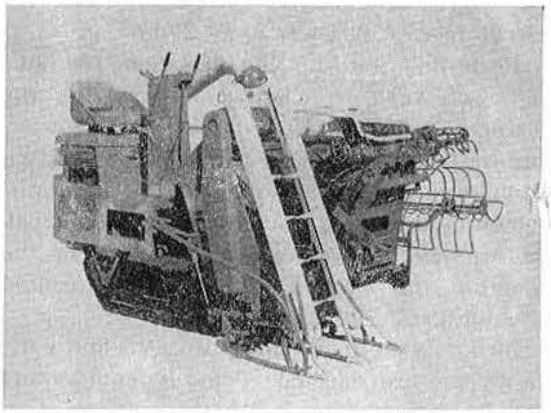

Fig. 4. Riding type 2 rows JIDATSU combine

A harvesting machine equipped with dual function, harvesting and threshing, is called a combine. The combine which is now in the developing stage in Japan is equipped with an axial-type threshing drum which is different functionally from foreign-make one. In case of the latter all of the harvested crops are fed to the rotating drum. On the other hand, in a Japanese combine, not all of the plant but the panicle is fed to the threshing chamber in the rotating direction of the threshing drum while the whole plant is conveyed in parallel with the direction of the axis of the rotating threshing drum.

We call this Japanese combine Jidatsu com-

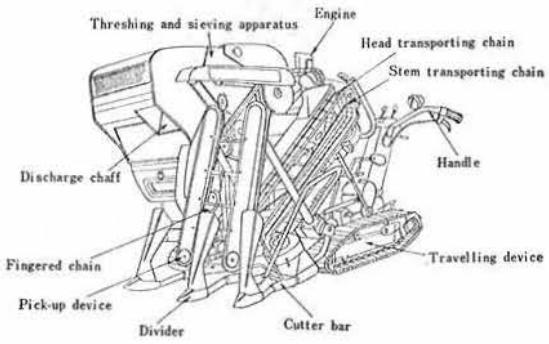

Fig. 5. Walking type 2 rows JIDATSU combine

bine.

As for the distribution of Jidatsu combine in Japan, 1,000 sets were distributed in 1967, 10,000 in 1968 and it is estimated that 50,000 sets will be distributed this year.

Construction of Jidatsu combine

Jidatsu combine, a unique Japanese model is constructed with engine, travelling device, cutting apparatus, pick-up apparatus, threshing and sieving section and straw disposing section.

Almost all of these combines are adopted a crawler to their travelling device aiming at higher workability and adaptability in paddy field than crossing over the levee or field work on the upland condition. Ground contact pressure of the travelling device is from 0.1—0.3 kg/cm^2.

Body weight of the combine is more or less 650 kg at its net weight and it is too light to destroy the soil structure of paddy plot and also harmless for land tillage work which is usually put into practice after harvesting rice.

Plants sometimes lodge due to various kinds of natural or cultivational conditions. So these plants have to be arranged in a clean and neat condition before cutting. This sorting work is performed by the divider and pick-up apparatus. The pick-up device consists of rotating chains with nylon fingers. By selecting the proper tilting angle of the pick-up device and rotating speed of the chain, we can improve the accuracy needed not only for raising the lodged plants or cutting itself, but for conveyance of plants to the threshing machine. And if not properly done, shedding of grains in this part may occur.

As for the cutter bar, it is made up of 50 mm knife sections, its wedge angle is around 20 degrees and the cutting angle is more or less 30 degrees. This cutter is a reciprocating type with the range of 1.0—1.5 cutting velocity ratio.

The cut and neatly arranged plants are to be threshed by the thresher mounted on the combine. The threshing device of the combine consists of the threshing drum, wire teeth planted spirally on it and a concave sieve with an 8-9 mm mesh.

In addition to the above structure, as for some kinds of model, a small rethreshing drum is installed.

Suction blower is the functional element in the cleaning section of the combine.

Harvested plants are held at the basal portion by the feeding chain running in front of the threshing section at the velocity of 0.2—0.4 m/s and while travelling inside of the threshing chamber in 1 or 2 seconds, they are to be threshed completely.

The mean required horsepower of the combine of this class varies to a certain extent depending on the travelling speed of the machine and harvesting capacity. When the travelling speed of the machine is 0.35 m/s and the throughput of grain is 350 kg/hr, it will be around 4 PS, travelling speed 0.6 m/s, throughput 800 kg/hr, nearly 8 PS. The distribution of horsepower in the combine is something like this, 50 per cent for travelling device, 10 per cent for harvesting device and 40 per cent for threshing device, respectively.

Operation of combine

The width of the cutter bar attached to those combines on the market is something like 50 cm. This width is far narrower than the overall width of the combine. Thus, a small stretch of paddy field has to be harvested by hand or any other means before combining, in the paddy plot of 10 a (20 × 50 m), 1.2 a is the minimum space to be disposed of before combining starts.

In case there is a vacant lot in the vicinity of the paddy plot, harvesting per hour is from 5 to 8 a.

In an event 20—30 a is regarded as the daily capacity of the combine due to such reasons that harvesting operation does not progress smoothly in the early morning because of dews dwelt on the plant and the grain dryer itself sometimes slows down its performance when we feed highly moistened grains to them.

Still, the Japanese farmer has shown a keen interest in this machine. This reason is ascribable to the low ratio of grain losses under 3 per cent, and grain damage 0.1—0.9 per cent irrespective of timing when harvesting is done under such various conditions, that color of the stems is still pale green indicating a high moisture content, or hard threshing varieties occupy the widest majority of the rice planted area in Japan.

In case of the foreign-type combine, grain losses are estimated as high as 10 per cent or more and grain damages 5 per cent or more.

Though the land ownership of one Japanese farmer is only 50 a in the mean paddy area, nearly a million of farmers owning more than 1 ha of cultivated lands are estimated to show a keen interest in mechanizing their harvesting work. Under such condition, the tendency of preference of accuracy to capacity of the machine will be maintained.