Recent Advances on Rice Transplanter

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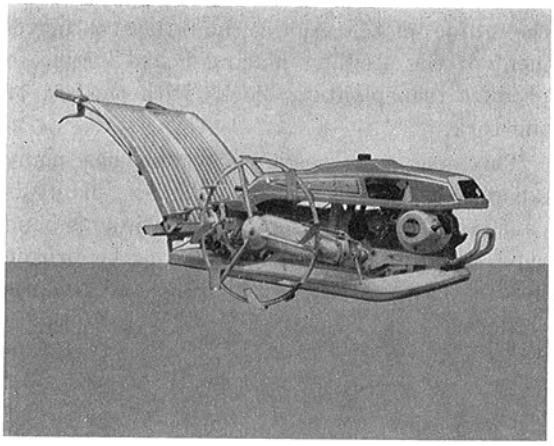
Though the author already reported on the development of paddy rice seedling transplanting machine in Japan (JARQ, Vol. 4, No. 2, 19–22, 1969), further progress has been made in the several years thereafter and now it is practically used by farmers.

The number of transplanters used in the fields was more than 400,000 in 1973 and an increase at the rate of more than 100,000 a year may be expected after that year. By further popularization of this machine, it is presumable that rice seedlings will be transplanted by the machine on more than 50 per cent of the paddy fields of Japan in a few years.

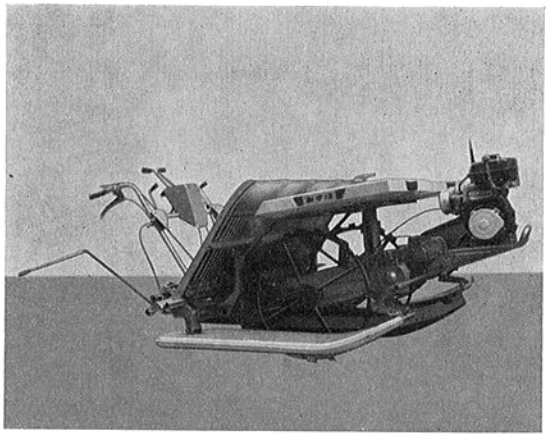
The transplanters can be classified into the machine for washed seedlings and machine for nonwashed seedlings by the difference of seedling forms as was already reported and the majority of the transplanters used today in Japan are the latter because the former lacks in precision and efficiency of planting and more labor is needed for pulling of seedling.

When the author made the previous report, the seedlings fed into the machine for nonwashed seedlings were mainly of band type and continuous band type, and the machine for mat type seedlings was yet in the infant stage of development. But at present, most of the transplanters practically used in the fields are the machines for mat type seedlings because their mechanisms and performances have been remarkably improved and also less seeding labor and no additional materials are needed.

The mechanisms of the transplanter which transplants band type and continuous band type seedlings were reported previously. As to the mat type seedlings, though they are raised in the nursery box as band type and continuous band type seedlings are done, the nursery box is not provided with partition plates as in that of band type seedlings, and seeds are broadcasted in the box. Consequently, the roots of the grown seedlings interwine with each other and form a mat type soil bed



A model of mat type seedling transplanter



Another model of mat type seedling transplanter

of seedlings. Therefore, soil can easily be put into the nursery box and seeding work is very simple, and much labor can be saved by using bed soil scattering scoop and seeder.

The seedlings in the form of a sheet of mat are taken out from the nursery box fed to the transplanter as they are, and then the transplanter cut the mat of seedling into blocks to be transplanted.

The mat of seedlings placed on a seedling placing board, moves side ways, sliding on a guide plate, are separated into blocks to be transplanted stump by a planting fork at a notch of the guide plate. And when one end of the seedling mat is advanced to the planting fork one row of blocks is cut off from the foremost end of the mat and the mat slides down in the lengthwise direction until the following foremost end of the mat reaches to the guide plate. Again the bilateral movement of the seedling placing board begins to produce transplanting blocks with the aid of the fork.

This mat type seedling system has many advantages because less missing plant is caused than in the case of the continuous band type seedlings which are prone to be broken before they are cut by the fork and because seedlings can easily be supplied and transplanting work can be performed continuously.

The planting fork, which cut off seedling blocks to be transplanted one after another, is attached on a planting arm and transplants the blocks trailing along an adequate line. Most of this type of transplanter works by means of link mechanism which is driven by a crank arm with the same mechanism of the band type seedling planter which was explained in the previous report.

The planting fork of the mat type seedling transplanter is different in form from that of the band type seedling transplanter which

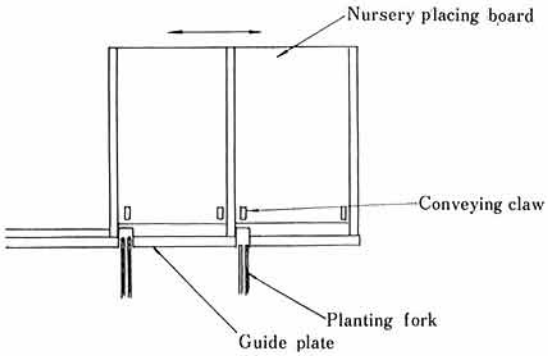


Fig. 1. Operating process of seedling placing board

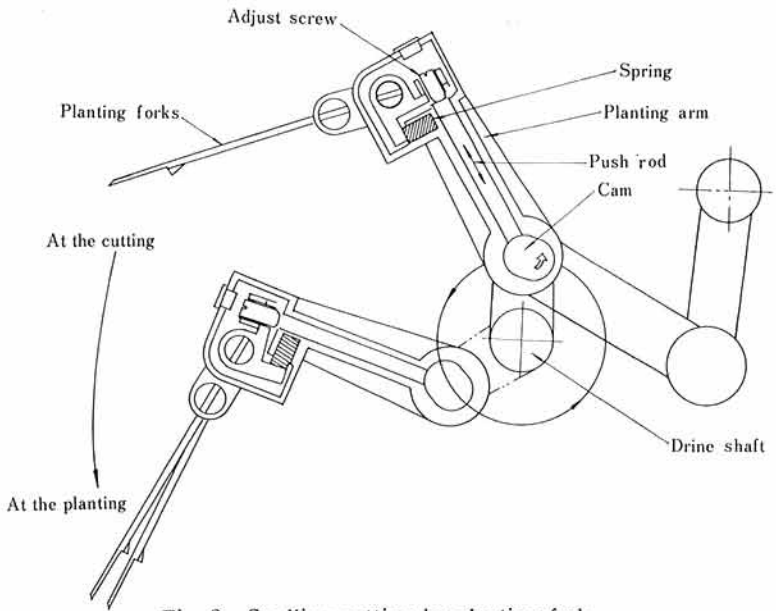


Fig. 2. Seedling cutting by planting fork

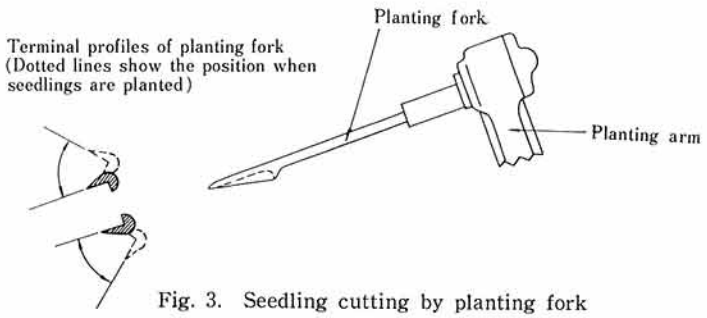


Fig. 3. Seedling cutting by planting fork

is provided with a single cutting edge to cut off seedling blocks because the form of seedlings to be fed to the machine is utterly different. That is, it is provided with a pair of claws of rod-like or other form which hold the cut block of seedlings between them and carry it to the transplanting position in the field and release the seedlings from the planting fork.

As to the releasing of the seedlings from the planting fork, there are two ways. In one way, the clearance between the two claws is changeable by shifting the claws; and in another way, two claws do not move but a supplementary claw push out the seedling. Fig. 2 to 4 show the cutline of these processes; that is, Fig. 2 indicates the way to widen the distance between two claws by means of the longitudinal movement of one claw to release transplanted seedlings.

Fig. 3 shows the way to widen the distance between the extreme points of two claws, which are possessed of convenient shape to hold seedlings, changing the opposite angles of two claws.

Fig. 4 shows the way to use the supplementary claw which is disposed upwards while the block of seedlings is cut off, and after transplantation, it comes down to release transplanted seedling putting them out from between two holding claws.

Thus, in the transplanting process of the mat type seedlings, the blocks of seedlings to be transplanted are cut one after another from the foremost edge of the mat, and the size of seedling block is determined by the lateral movement of the seedling placing board per

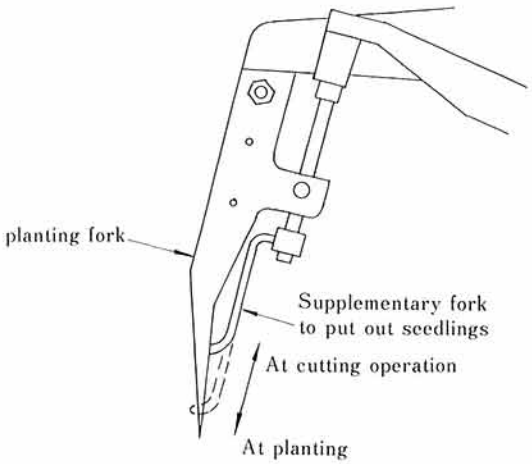


Fig. 4. Seedling cutting by planting fork

one process of the planting fork and by the longitudinal cutting length of the planting fork.

To accomplish this cutting successfully the seedlings must be sent to touch closely to the guide plate when the seedling placing board is moved to the extreme end after one lateral row of the seedling is cut.

Therefore, the seedling placing board is

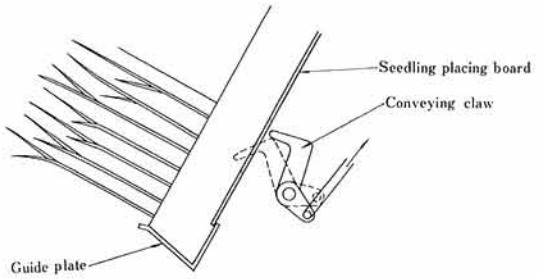


Fig. 5. Longitudinal sending system of seedlings

inclined to make seedlings slide easily on the board, and a longitudinal feeding device is equipped to ensure the sending process. Fig. 5 shows one example of this mechanism.

In the early stage of the development of the rice transplanter, most of the machines were not equipped with engine and travelling mechanism but were operated by the power supplied from the PTO shaft of a tiller. But in this system, the weight of machines becomes too heavy, and the performance of the machine often lacks in precision of transplanting work on an uneven hard pan. Consequently, a self-propelled transplanter equipped with an engine and a travelling mechanism was devised and used.

The popular transplanter of today is all equipped with a float which glides on the soil surface supproting partial weight of the machine, and the rest of the weight is supported by the wheels which can travel on the paddy field.

In the early days, the float and wheels were fixed on the transplanter without any adjustment between them. Therefore, the weight distribution of the float and wheels sometimes became unbalanced according to soil hardness and depth of the hard pan. Consequently, the adaptability of the machine to the change of field conditions was very little.

But recently, the relative positions of the float and wheels on the machine are adjustable and their performance can be kept balanced to a certain extent by means of springs; therefore, the adaptability of the machine to field condition became large. And for some further improved machines, the height of the wheels is adjustable automatically according to the change in depth of the hard pan by means of a hydraulic cylinder.

Besides such improvement of the elemental parts of the machine, the number of transplanting rows was developed, and four-row transplanting machines are found in the market as well as the two-row ones. But there exists little substantial difference between these two types, that is, the four-row transplanting machine is also of a pedestrian type equipped with a float. The transplanter which can transplant more than four rows, if needed, must be a riding type because of the physical limit of the operator. But such multiple row transplanter is not yet practically used in the fields, though some experimental tests have been carried out.

Besides the general description of the mechanism of the transplanter the specification of a popular transplanter may be as follows; row spacing is about 30 cm (not adjustable), spacing in the row is 12 to 18 cm (adjustable), output of engine (gasoline) is about 2 ps for two-row transplanter and 3 ps for four-row transplanter, weight of machine is 60 to 70 kg for two-row transplanter or 120 kg for four-row transplanter, transplanting speed is 0.4 to 0.6 m/s, transplanting time per 10 a is 1.5 to 2.0 hours by two-row transplanter and 0.7 to 1.0 hours by four-row tarnsplanter and missing plant rate is less than five per cent when the seedlings and fields were prepared adequately.

At first, the transplanter for nonwashed seedlings was made to plant young seedlings, having two to three leaves, grown in the nursery box unlike traditional hand transplanting seedlings.

Later a new type transplanter which can transplant more grown seedlings have gradually been desired owing to increase in efficiency and utilization of the machine for young seedlings. But it is difficult to obtain large seedlings by means of the raising of seedling in a box (30×60×3 cm) in which 200 g of seeds are sown. The seeding rate per one box, therefore, must be decreased to get larger seedlings. But when the seeding rate decreases, it results in increasing the size of seedling blocks which are cut by the transplanter. Consequently nursery boxes must be increased in number per unit area of transplanting. So there is also a limit in the decrease of seeding rate.

In consideration of these points, a new raising system of seedlings which are more grown and have about four leaves was developed. In this system, the seeding rate is

decreased to about 100 g per one box, and a seedling box with many holes on its bottom is placed on the soil surface, so that roots develop deeper into the soil through the holes.

As the result, these holes can compensate the want of bed soil in the box and can grow the seedlings older than young seedlings. Thus grown seedlings are called medium seedlings because their size is intermediate between that of grown seedlings and that of young ones.

As to the raising of the mat type medium seedlings, porous polyvinyl film can be used instead of the holed nursery box, that is, a frame is set on the porous polyvinyl film spread on the ground surface, and seeds are sown in the bed soils put in the frame to grow seedlings.

The size of the medium seedling blocks cut by the planting fork must be greater than that of young seedlings, however the mat type seedling transplanter in the market today can deal with the transplanting of medium seedlings, in due consideration of this point.