Manual for Using Zero-Till Seed-cum-Fertilizer Drill and Zero-Till Drill-cum-Bed Planter

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ICAR

National Agricultural Technology Project
Indian Council of Agricultural Research
Rice-Wheat Consortium for the Indo-Gangetic Plains

Rice Wheat

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The initial support from the Asian Development Bank and International Fund for Agricultural Development provided the groundwork for establishment of the RWC in 1994 and formalizing the collaborations between the NARS, IARCs and ARIs. The NARS-driven strategic ecoregional research initiatives with financial support from the Governments of the Netherlands, Sweden, Switzerland, Australia and the US Agency for International Development and the World Bank have grown over the years into a dynamic agenda of resource conservation technologies appropriate to different transects of the Indo-Gangetic Plains. The on-going successes in scaling-up resource conservation technologies for enhancing productivity and sustainability of the rice-wheat systems are beginning to create a revolution and favourably benefit large areas and more numbers of farm families.

Cover pictures:

Top left: Wheat planted on raised beds with rice residue incorporated
Top right: Zero-till planted wheat in rice stubbles
Bottom left: Wheat on raised beds in manually harvested rice field
Bottom right: Zero-till planted wheat in control traffic plot (Tractor movement restricted)

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Manual for Using Zero–Till Seed-cum-Fertilizer Drill, and Zero–Till Drill-cum-Bed Planter

I. Introduction

For enhancing the productivity and sustainability of the rice-wheat system without seriously affecting the natural resource base and the environment, several resource conservation technologies have been developed and are being promoted across the Indo-Gangetic Plains. There is plenty of reliable evidence to indicate that zero-tillage, and development of a permanent raised bed planting or furrow irrigated bed planting system are becoming increasingly popular with the farmers in the region. The reasons for this are obvious. Zero tillage reduces tillage to only one pass. It allows more timely sowing, which raises yields and lowers costs by saving soil, fuel, tractor costs, water, fertilizer and herbicides. Similarly, bed planting has many advantages in regard to water savings, mechanical weeding possibilities and fertilizer placement, bolder grain production, less lodging and better crop stand. When this is combined with zero-tillage, the permanent beds may become more favourable for farmers since bed-making costs are reduced. Development of zero-till seed-cum-fertilizer drill by Govind Ballabh Pant University of Agriculture and Technology (GBPUA&AT) based on a model from Newzealand has played a key role in facilitating the adoption of the zero-tillage system of crop establishment.

The main constraint with zero-till seed-cum-fertilizer drills, widely used for flat planting, has been when farmers want to retain loose residues of the previous crop. Also the other difficulty was how to use zero-till drill for planting wheat and other crops in raised bed and furrow irrigation system. In order to meet these twin needs, the national agricultural research and extension system developed several versions of zero till seed-cum-fertilizer drill and bed planter prototypes. These prototypes are being improved continuously by manufacturers (Fig.1) with active involvement of the national scientists using the feedback from user farmers. As a result of these efforts, even a add-on machine which serves both the purpose of a zero-till drill and of a bed planter and which can seed most of the common crops is now available.

In the present publication, an attempt has been made to develop a manual for zero-till seed-cum-fertilizer-drill and zero-till drill-cum-bed planter to provide the essential and relevant information on how to use and maintain these agricultural machines properly for obtaining the optimum performance.

Fig. 1. Zero-till seed-cum-fertilizer drill — an improved version with disc openers under field testing.

II. Zero-Till Seed-cum-Fertilizer Drill

With the significant increase in the adoption of zero-tillage and bed planting technologies in several areas of the Indo-Gangetic Plains, zero-till seed-cum-fertilizer drill has become a very useful and important agricultural machine for the farmers. It helps them to seed a crop directly into the cultivated field just after the harvest of the previous crop with the least disturbance of the soil. It eliminates or reduces time and energy intensive conventional tillage operations reducing the cultivation costs and risk of *Phalaris minor* in wheat apart from improving crop yields and farmers profits.

Fig. 2. Rabi seed-drill commonly used by farmers for conventional sowing.

Zero-till seed-cum-fertilizer drill comes in many models and sizes. Basically all the new models are improved versons of the Rabi seed drill (Fig. 2) used by the farmers for decades. The seed drilling is accomplished in a narrow slit created by a zero-till seed-cum-fertilizer drill.

Major Components and their Description

Major components of the zero-till seed-cum-fertilizer drill (Fig. 3) are:

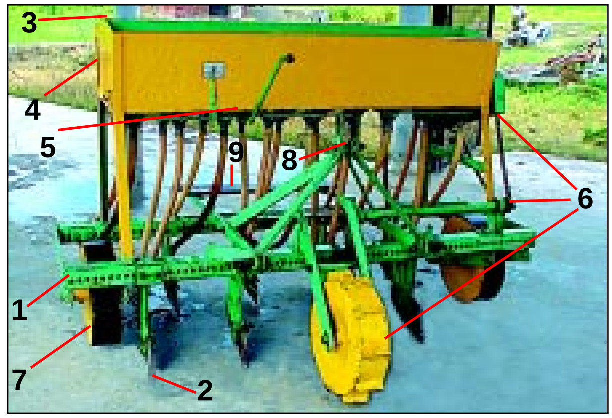

Fig. 3. Zero-till seed-cum-fertilizer drill and its major components.

1. Frame
2. Slit/furrow openers
3. Seed and fertilizer boxes
4. Seed metering device
5. Fertilizer metering device
6. Power transmission unit
7. Depth-control side wheels
8. Hitch points
9. Iron/wooden platform or stand

A brief description of each of the above components is given below :

Frame

The frame of the zero-till drill is of the size of 185 × 60 cm. It is made of two mild steel angle irons (6.5 × 6.5 × 0.5 cm) welded together to provide the desired strength and rigidity. This is true in a drill of 9 tines but in 11-tine drill, the length of frame is about 220 cm. Holes 1.2 cm in diameter and 2.5 cm apart from each other

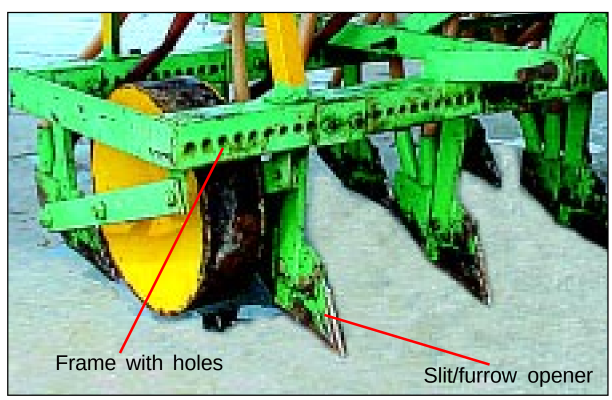

Fig. 4. Frame with holes, and slit/furrow openers.

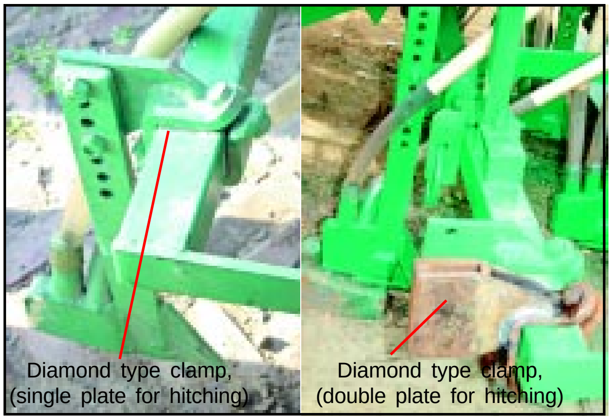

Fig. 5. Diamond/box type fastening clamps

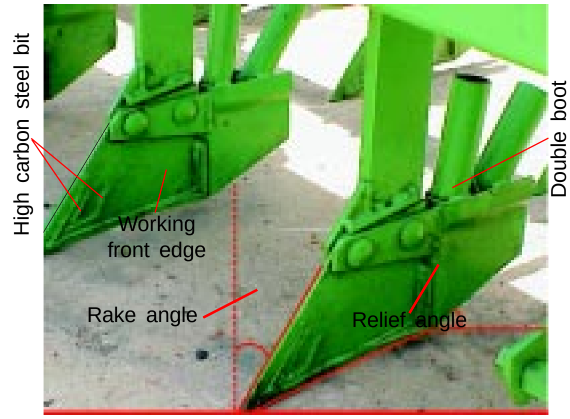

Fig. 7. Rake angle and relief angle of the furrow opener.

are provided in the frame (Fig. 4), to vary the spacing between furrow openers. These, however, weaken the frame. In new models, provision for fastening clamps (diamond/box types) (Fig. 5)has been made to overcome this drawback. The machine can easily be drawn with the help of any 35 HP tractor. The height of the machine ranges from 110 to 145 cm and weighs around 250 to 260 kg and even up to 350 kg in some models.

Slit/furrow Openers

The zero-till seed-cum-fertilizer drill has 9-13 inverted T-type slit/furrow openers (Fig. 6) depending on the model or brand. These can be spaced as needed in different crops. These T-type slit/furrow openers when attached to a tine open a narrow slit 3-5 cm wide. In Fig. 4 the slit/furrow openers provided in zero-till seed-cum-fertilizer drill are spaced 17.5 cm apart. The cutting portion of the slit/furrow openers is made by using 8 mm thick high

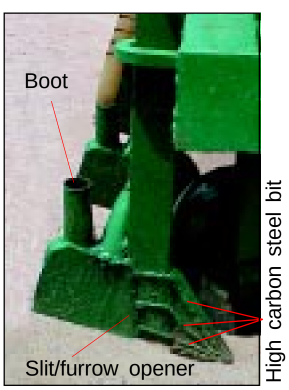

Fig. 6. Slit/furrow opener and the boot.

carbon bit (Fig. 6) welded to a mild steel plate. The working front edge (Fig. 7) of the slit/furrow openers has a piece of carbon steel (hardness 65 RHN) welded all round the nose, tip and sides to reduce wear and tear. In some drills, manufacturers have provided chisel type slit/ furrow openers. The rake angle (Fig. 7) is generally kept at around 20 degrees in order to make a narrow slit with minimum of soil disturbance. The relief/clearance angle of the slit/furrow openers is normally kept at 5 degrees. The relief angle (Fig. 7) can be further adjusted with the help of the top link to vary seeding depth. A 4 cm wide, 5 cm thick and 6 cm long stiffener plate is provided at back bottom of the T-type slit/furrow opener (5.0 x 1.2 cm) which is attached to the frame with nuts and bolts or directly with clamps. The furrow opener is welded to the mild flat steel shank (straight leg standard mounted with T-type slit openers). The blades can be of “welded on” or “bolted on” or even “knock down” type. The disadvantage of “welded on” blades is that they require machine shop for replacement, whereas, a farmers himself can replace the other two types of blades. The quality of material used to make the slit/furrow openers will ultimately decide the operational quality and durability of the drill. Double boot (Fig. 7) is provided behind each furrow opener to receive a tube (steel ribbon or polyethylene tube with a minimum diameter of 25 mm) each from seed and fertilizer metering devices. The furrow openers are adjusted to make 3–5 cm wide and deep slits. The depth of seeding can be adjusted by raising or lowering the depth-control side wheels. However, depth of seeding can also be adjusted (independent of the depth-control side wheels) by raising or lowering the shanks of the furrow openers. The depth control can also be effected with three point hitch hydraulics, in addition to the depth-control wheels. The top link is used to level the seeder. The unleveled machine may otherwise lead to variable seeding depth in different rows. The machine can be properly leveled by a three-point linkage. Since the side link hydraulics often get damaged or become non-functional in most tractors with the farmers, it is advisable to use the depth-control wheels or the top link.

Seed and Fertilizer Boxes

Trapezoidal shaped seed and fertilizer boxes, made of mild steel sheet (2 mm thick), are mounted side by side on the frame, fertilizer box (Fig 8b) in front and seed box (Fig. 8a) in the rear. The boxes are generally 145 cm long and 28 cm deep sufficient to hold 50 kg DAP and 50 kg wheat seed at one time, respectively. Box dimensions can vary but these generally depend upon the effective width of the machine and will increase with the increase in the number of the slit/furrow openers. For example in case of 11-tine drill, the length of seed and fertilizer boxes will be around 178 cm.

Fig. 8. Inner view of (a) Seed, and (b) Fertilizer boxes.

Seed Metering Device

Seed metering device has the following components (Fig. 9):

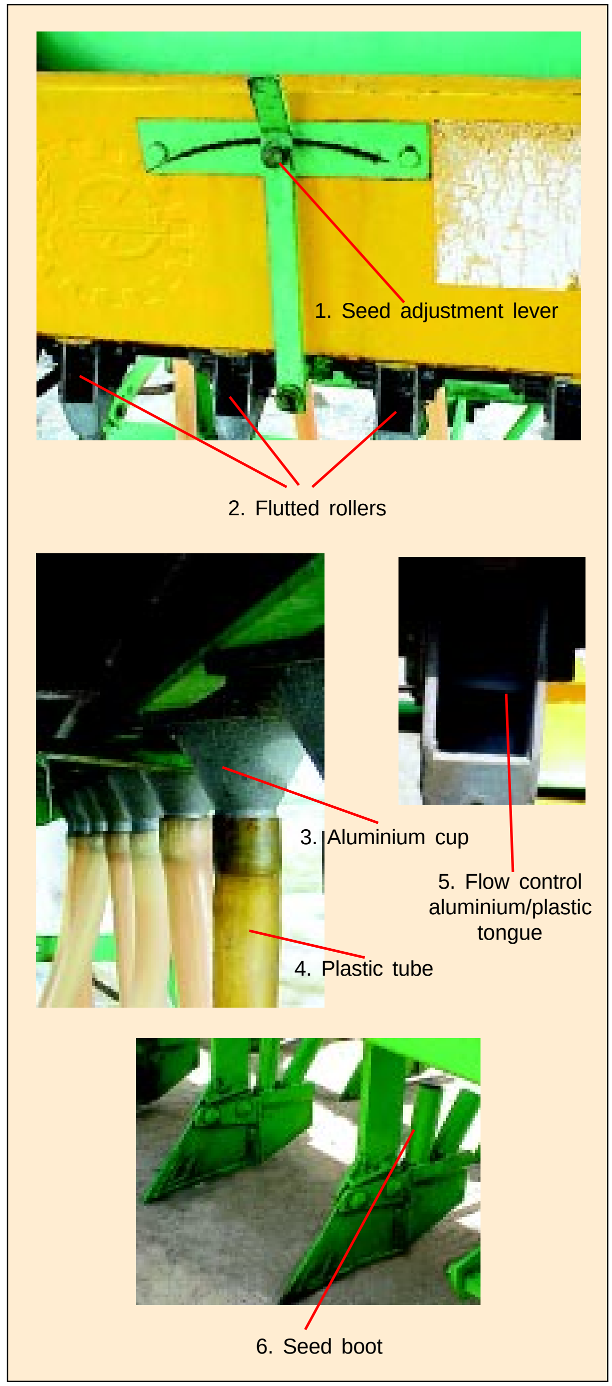

Fig. 9. Seed metering device and its components.

1. Seed adjustment lever
2. Flutted rollers
3. Aluminium cup
4. Plastic tube
5. Flow control tongue
6. Seed boot

Flutted rollers made of aluminium facilitate continuous seeding of crops where control of plant to plant distance is not needed (wheat, rice, *toria* etc.). Tooth size, depth of groove and the number of flutes depend on the seed size. For example, there are 10 flutes in each roller for wheat seed. The rollers are fitted in a series on a shaft. Aluminium cups are fitted on these rollers. Below the flutted rollers are aluminium or plastic tongues to hold the seed. The tongues can be raised or lowered depending on the size and texture (in case of rice) of the seed. As the flutted rollers turn, they push the seed over the edge of the seed cups attached at the bottom of seed metering box which funnels the seed through the plastic seed tubes to the slit/furrow opener. In funnel shaped boot, a deflector plate is provided for separation of seeds and fertilizer. A very precise seed rate adjustment is obtained by sliding the flutted roller in or out. The more is the exposed area of the flutted roller, the higher will be the seed rate and vice-versa.

Calibration of seed-drill (in laboratory)

i. Measure the diameter (D) of the drive wheel and calculate its circumference i.e. πD in meters.

ii. Measure the effective width of coverage (W) in meters of the drilling machine by multiplying number of furrows with spacing.

iii. Then distance/length (L) to cover one hectare is calculated by dividing 10000 m^2 (area of one hectare) by effective coverage (W).

iv. The distance (l) i.e. l/100th of a hectare will be equal to L/100 in meters.

v. To cover distance l, the drive wheel has to take 'n' turns i.e. = $l/\pi D$

vi. Allowing 10% slippage, the distance can be covered in 'N' turns i.e. = (n–0.1 n)

vii. Raise the seed drill so that drive wheel becomes free to be turned. Put a chalk mark on the rim of the wheel. Fill the seed box, set the seed rate adjusting lever and rotate the wheel for 'N' turns.

viii. Collect the total seed under the seed-drill and measure its weight. Thus seed rate per hectare can be calculated. Any change in the seed rate, if required, can be accomplished by adjusting the lever and recalibrating the machine till the desired seed rate is obtained.

ix. Weigh the quantity of seed dropped from each opener and record on the data sheet to know the variation in different rows, if any.

***Example**, say*

- Circumferance of the drive wheel = 0.4 m
- Width of machine = 1.85 m
- As we know area of one hectare=10,000 m^2
- Then distance/length (L) to cover one hectare will be =(10,000/1.85)=5405.4 m
- The distance (l) i.e. 1/100 of hectare will be = 54.5 m
- To cover distance (l), the drive wheel has to take turns (n) = 54.5/0.4=136.25
- Allowing 10% slippage, the distance (l) can be covered in 'N' turns (n–0.1n) = 123 (approx.).

Put seed and fertilizer in the boxes. Set the rate control adjustment lever as prescribed by the manufacturer. Rest of the procedure will be similar as described above at items vii-ix.

Calibration of seed-drill (in situ)

Select the recommended spacing (row to row spacing) and seed rate for the specific variety of crop to be sown.

Draw a line (dotted line as shown in Fig. 10) passing through the recommended spacing on line A, seed rate on line B and extend it further to join the line C of the nomograph. This point of intersection on line C will give the desired seed quantity to be dropped per meter length per row.

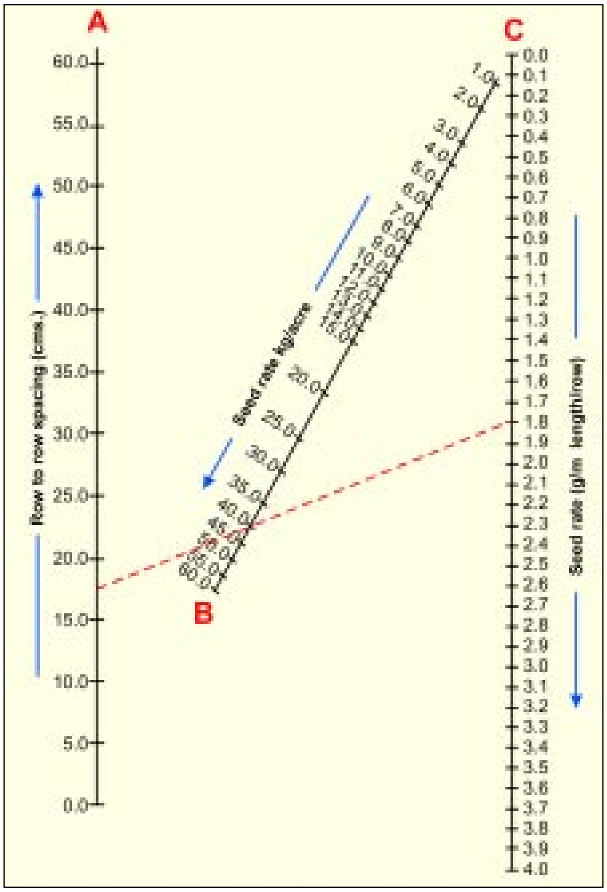

Fig. 10. Nomograph for seed-drill calibration.

Validation of the seed-drill calibration

Fill the seed box with seed and set the indicator at desired seed rate according to the chart given by the manufacturer. Mark a distance of 10 to 20 meters in the field. Run the seed drill and collect the seeds in each tube for 10 to 20 meter length run.

The amount of seed collected in each tube in 10 or 20 meter run is then expressed in g/meter. This quantity should be equal to the calculated seed quantity obtained from the nomograph in g/meter length/row. If the measured quantity is less or more, adjust the rate with the help of seed metering lever. Sliding the roller out will increase seed rate. Now, the seed drill is ready for planting the specific seed.

Example:

Supposition: Seed rate planned = 40 kg/acre
Spacing row to row = 17.5 cm
Plant to plant spacing = continuous

Draw a straight line (dotted line as shown in Fig. 10) joining 17.5 cm on line A and 40 kg/acre on line B and extend it further to intersect on line C at seed rate 1.8 g/meter length/row. So, the amount of seed for 10 meter length run per row = 1.8 x 10 = 18.0 g. Therefore, the farmer should collect 18.0 g seed in each tube for 10 meter run of the machine in the field. If the quantity of seed collected is low/high, then he should adjust it with the metering lever. If we know the seed test weight (weight/1000 seeds) we can calculate the number of seeds/meter row length using the intersected value (e.g. 1.8 g, Fig. 10) as follows.

No. of seeds/meter row length (x) = 1000/seed test weight × 1.8 g.

Since the farmers do not have weighing machines, it is advisable to calibrate with seed number/m row length. For this it is better to calibrate number of seeds with the number of revolutions of the drive wheel. If the circumference of the drive wheel is one m, then the lenth covered in 1 turn is also one meter. and x number of seed will fall.

Fertilizer Metering Device

The fertilizers metering device (Fig. 11) has the following components:

1. Bottom of the fertilizer box with diamond shape holes
2. Scale
3. Fertilizer setting lever
4. Aluminium cup
5. Agitators
6. Flutted roller
7. Diamond shape holes
8. Fertilizer metering shaft (sometimes coated with plastic to avoid rusting)

The fertilizer metering device generally used in drills is of hole mesh type (gravity-cum-forced feed type) arranged on a shaft. Sometimes it is called an agitator type fertilizer

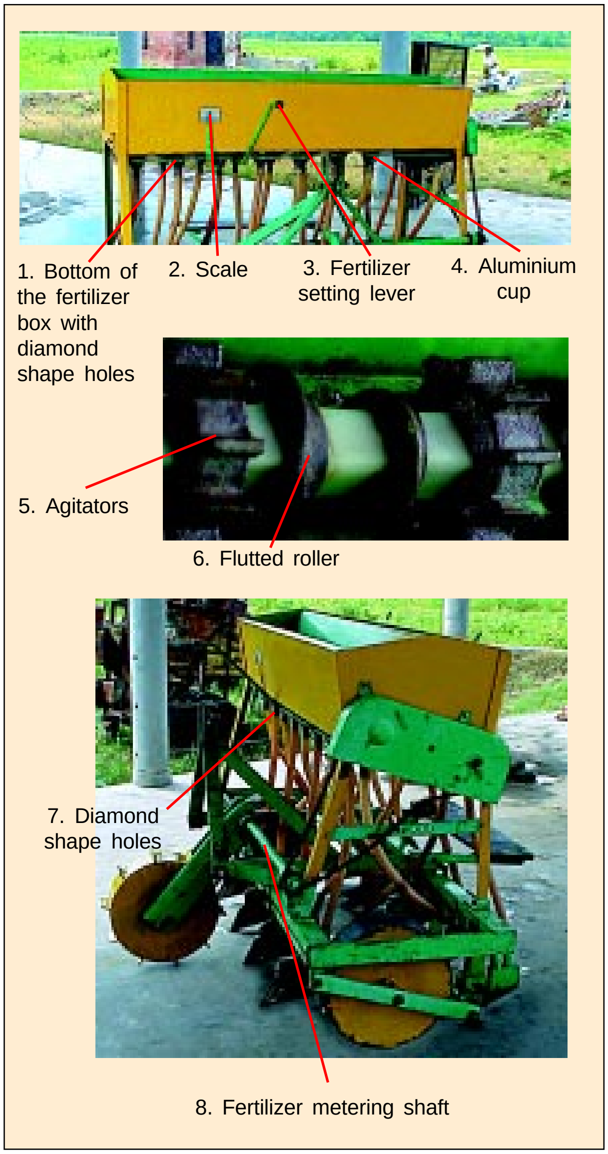

Fig.11. Fertilizer metering device and its components.

metering device. In the bottom of the fertilizer box, diamond shape holes are made. The quantity of fertilizer is adjusted by adjusting the size of these holes. Star shaped agitators are provided to avoid the bridging of fertilizer and to feed fertilizer continuously through the holes. The fertilizer setting handle/lever with scale is provided to adjust the required quantity of fertilizer. The fertilizer passes through the hole, into a funnel, to deliver fertilizer into the slit/ furrow opener boots.

In other machines, fertilizer box delivers the material to a cup fitted with rotating cells (Fig. 12). The rotating cells pick up the fertilizer granules (small or large) and deliver them to the fertilizer tubes. This mechanism has the advantage of handling small or large sized fertilizer granules such as urea supergranules (USG) and place them at desired soil depth. Deep placement of USG in rice culture is known to improve efficiency by 20%. Also there is no free flow of fertilizers on turnings of the tractor at field corners.

The rotating cell type fertilizer metering device has the following components (Fig. 12):

1. Fertilizer tank
2. Shaft
3. Rollers
4. Cells/cups
5. Funnel
6. Leveling screw

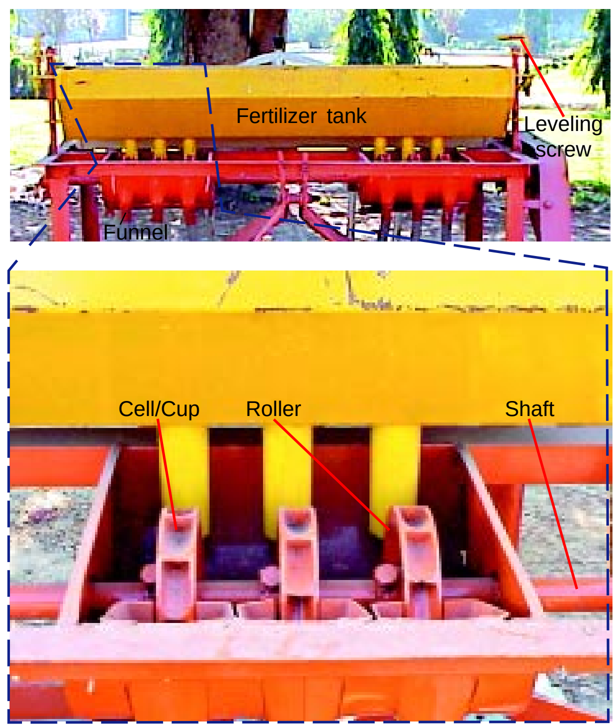

Fig. 12. Rotating cup/cell type fertilizer meter

In cell type fertilizer metering device, cells are fitted in separate compartments to allow fertilizer placement as required in each row or some select rows only. Fertilizer can be increased or decreased by lifting or lowering the fertilizer tank. respectively or by changing the sprocket wheel.

Fertilizer is simply metered by a series of cups on a roller. However, calibration of machine for setting required rate of fertilizer under laboratory situation as well as *in situ* can be accomplished with similar procedure mentioned earlier under the headings “Calibration of seed-drill (in laboratory)” and “Calibration of seed-drill *(in situ)*”.

Power Transmission Unit

Power transmission unit (Fig. 13) has the following main components:

1. Drive wheel
2. Shaft
3. Idler
4. Sprocket
5. Roller chain

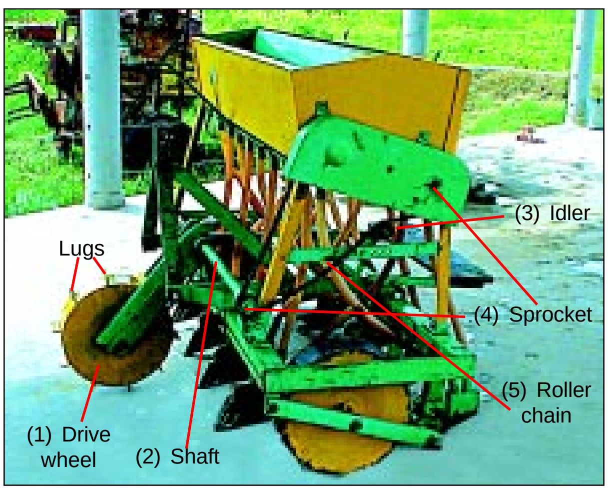

Fig. 13. Power transmission unit and its main components.

The power required to operate the seed and fertilizer metering devices is provided by a floating type lugged drive wheel 40 cm in diameter and 10.5 cm in width through chain and sprockets. However, size of the drive wheel may vary in different models. Fourteen lugs each of 3 cm height at an angle of 90^0 are provided on the ground wheel to avoid slippage. Wheels are of iron closed type or with rubber on them for better traction. This ground wheel or drive wheel is attached to the frame in front. Traction can be adjusted through a groove and spring as desired. Attachment of drive wheel in the front side of the frame sometimes creates problem in the free movement of wheel due to soil or stubble blockage or due to its location being very near to the hook of the tractor. So now this wheel is being attached on the rear side of the machine in new models (Fig. 14). A motorcycle roller chain of 12.50 mm pitch with 14 and 37 number of teeth on the mild steel sprocket is provided for power transmission from the drive wheel to seed and fertilizer metering devices. Power from ground wheel is transmitted to a shaft (1:1) (Fig. 13) mounted on front frame. From this shaft power is transmitted to seed and fertilizer metering shafts (2.5:1) through the chain sprocket arrangement. However, size of roller chain and sprocket can vary in different models as per requirements. An idler has been provided to tighten or loosen the chain for its smooth running.

Fig. 14. Drive wheel attached on the rear side.

Depth-control Side Wheels

Two wheels (one on either side of the drill), each of 40 cm diameter (Fig. 15a) made of mild steel sheet (closed type) or in some models made of rubber, are provided to set the required seeding depth. The size of these wheels may vary in different models. With the help of depth adjusting screws (Fig. 15b), these wheels can be raised or lowered to increase or decrease the depth of seeding, respecitvely. The depth

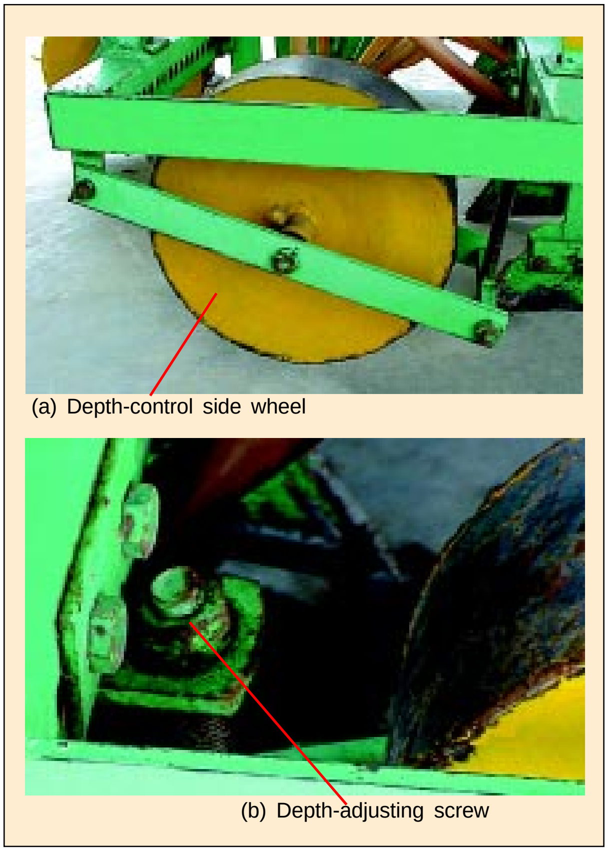

Fig 15. Depth-control side wheel (a) and depth-adjusting screw (b).

of seeding in case of wheat varies from 3–5 cm. However it can be adjusted as per requirement.

If there is a large amount of loose straw in the field, these depth wheels can get jammed with the straw. If this happens, the depth-control wheels can be removed and depth control maintained with the tractors' hydraulics, to reduce straw jamming.

Hitch Points

The drill has three standard hitch points; two lower and one upper (Fig. 16). The machine is attached to tractor through these three hitch points with the help of link pins. The top link hitch point also helps in leveling the machines

Iron/wooden Platform or Stand

An iron/wooden stand or platform is also attached to the rear side of the frame (Fig. 17).

Fig. 16. Hitch points.

One person can either stand or sit on this platform while the machine is in operation just to keep a watch that the seed and fertilizer are running properly through the respective plastic tubes without any blockage. This is just a precautionary measure and not a requirement *per se*. It may be mentioned that this practice enables the sitting person to remove the raked residues as well. Therefore, it is advisable if this practice is followed.

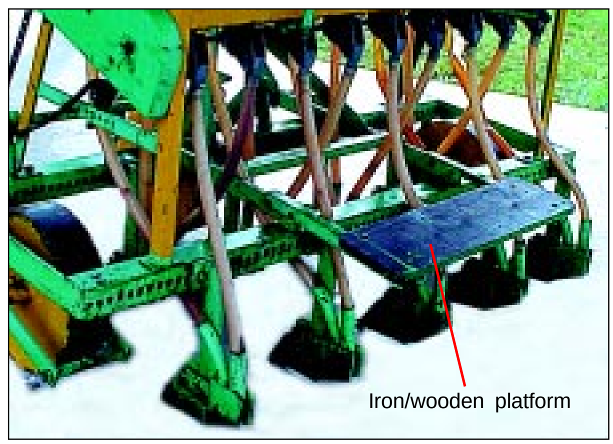

Fig. 17. Iron/wooden platform attached to the rear side of the frame.

Precautions for Use

- Sowing of wheat with zero-till seed-cum-fertilizer drill is best accomplished when soils have 3-4% more moisture than under conventional method. Germination of wheat and other crops is adversely affected if the soil is too dry.

- Conversely, zero-till machine does not work well in fields where moisture levels are too high (wheel slippage) and under such situations care must be taken to prevent blockage of seed and fertilizer tubes.

- Earlier sowing of wheat (last week of October to 15 November) is possible under zero tillage and yields are generally higher as compared to late sowing of wheat. This is due to less infestation of weeds (*e.g. P. minor*) and more efficient nutrients-water interactions.

- Heat stress at grain filling is less in late winter season when temperature begins to rise. The overall growth period of crop is more in early sowing.

- Longer duration varieties such as PBW 343, HD 2687 having better vigour at early growth and profuse tillering cover the soil surface and are more competitive with weeds. Select cultivars with better competing attributes.

- There is no need of planking before or after planting crops with zero-till drill

- When weed pressure is not a factor, tilling of soil is not needed and reduced tillage (1–2 plowings) and cross-sowing methods do not provide any additional advantage over zero tillage. Rather these methods may reduce germination and yield and induce germination of *P. minor* besides increasing the cost of cultivation.

Fig.18. Pre-germinated *P. minor* before sowing under zero-tillage.

- Germination and emergence of wheat is not adversely affected even if rains occur just after sowing of wheat because crust formation does not take place under zero tillage. However, crop planted with zero till in reduced tilled plots may bury seed deeper and may adversely affect crop stand.

- Germination of *P. minor* is reduced by 30–40%, if soil disturbance is reduced to the minimum as in the case with the zero tillage. *P. minor* seed generally fail to germinate if seed depth is > 5 cm.

- Herbicides like Round up/Glycel (glyphosate) @ 0.5% (5 ml/l of water) or Gramaxone (paraquat) @ 0.3% (3 ml/l) in 100 1 spray volume/acre are helpful in controlling pre-germinated populations of *P. minor* (Fig. 18). This avoids use of preparatory tillage. Post-emergence herbicides such as clodinafop @ 60 g/ha (Topik @ 160 g/acre), fenoxaprop @ 120 g/ha (Puma Super @ 480 g/acre) or sulfosulfuron @ 25 g/ha (Leader @ 13.5 g/acre) have been successful in controlling weeds (*P. minor*) after germination of wheat. In case annual weeds are present at the time of seeding, Gramaxone (paraquat) @ 0.3% (3 ml/l of water) may be used but in the presence of perennial weeds Round up or Glycel @ 1.0% solution should be preferred. However, herbicides should be applied at a proper time and in recommended dose with knapsack sprayer fitted with flat fan nozzle tips. It is advocated that use of post-emergence herbicides must be rotated each year to reduce the capacity of weeds to develop resistance. Spray should be accomplished at 2 to 3 leaf stage of *P. minor*.

- It has been observed that farmer can skip the use of herbicides when zero tillage and alternate herbicides are carefully integrated for 3–4 years.

- Irrigation immediately after sowing of wheat is not recommended. If needed, post-sowing irrigation may be given a week ahead of conventionally practiced irrigation schedule.

- Possibilities of emergence of broadleaf weeds in place of *P. minor* under long-term zero-till fields are well expected. However, it will be comparatively easy and cheap to control broadleaf weeds in wheat using herbicides like 2,4-D or metsulfuron. Based on long-term permanent trials since 1997/98, it has been observed that there is no significant shift in weed flora till date.
- Encouraging results of wheat sown with zero-till machine have also been realized under saline, and alkali soils.
- Zero-till sowing of wheat is possible in standing stubbles of paddy (after harvest) without burning (Fig. 20), which not only adds residue in the soil to increase and improve its quality but also prevents environmental pollution. If loose straw of paddy is lying on the soil surface, it should be collected aside before seeding to avoid interruption in the seeding operation and uniformly broadcast it after seeding to serve as mulch.
- There is no need to change use of nitrogenous and phosphatic fertilizers rate in zero tillage. Keep application rates the same as followed under conventional method of planting.

Fig. 19. Sowing of wheat with zero-till seed-cum-fertilizer drill in standing stubbles of paddy without burning.

III. Zero-Till Drill-cum-Bed Planter

Zero-till drill-cum-bed planter (Fig. 20) is a prototype which has been developed by combing a zero-till seed-cum-fertilizer drill with a bed planter. Efforts have been made to incorporate the functions of these two separate machines in one combined unit. It can be used to harness the benefits of both zero-till seed-cum-fertilizer drill as well as of a bed planter and guidelines and instructions for its use should be followed accordingly.

Major Components and their Description

Zero-till drill-cum-bed planter has the following major components (Fig. 20):

1. Frame
2. Slit/furrow opener
3. Ridger and bed-cum-furrow shaper
4. Seed box and fertilizer boxes
5. Seed metering device
6. Fertilizer metering device
7. Power transmission unit:

   (a) Driving wheel and (b) Sprocket
8. Hitch points
9. Iron/wooden platform or stand
10. Depth-control side wheels
11. Interculture tines

Frame

The frame of zero-till drill-cum-bed planter (Fig. 20) has a size of 215 x 80 cm and it is made from mild steel channel section of size 75 x 40 mm. Unlike simple zero-till machine, zero till-drill-cum-bed planter has a 3 bars frame for attachment of replaceable parts such as depth-control wheel, shovels, tines and shaper. Two channel sections placed one above another (three in number at 180^0) at a spacing of 1.5

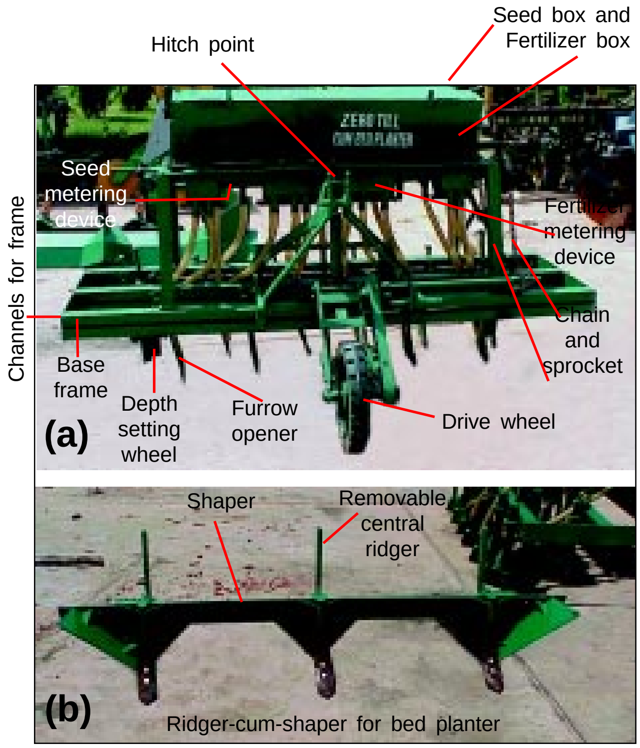

Fig. 20. Zero-till drill-cum-bed planter and its major components.

cm are welded with a side plate of the size 100 × 5 mm. Clearance of holes 1.5 cm is provided for fitting shank of furrow openers to the frame with the help of U-clamp bolts. New model has box type pipe frame for improved frame strength.

Furrow Point Openers

In the combined unit, the machine has chisel type 9-13 furrow openers, 17.5 cm apart. However, the space between furrow openers can be adjusted as per requirement. The cutting portion of chisel type point opener which makes a very narrow slit is made by using 8 mm thick mild steel plate with a working front of hard steel (Fig. 21). The working front edge of furrow opener is coated with electrode of carbon steel to reduce wear and tear. The rake angle (Fig. 22) has been kept at 20 degrees in order to make a narrow slit without causing much soil disturbance. The relief angle (Fig. 22) of the furrow openers has been kept at 5 degrees. The furrow opener is welded to mild flat steel shank (5.0 × 1.2 cm) which is attached to the frame with nut and bolts or

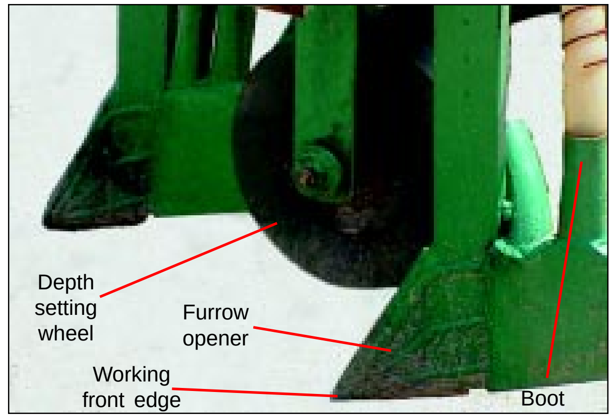

Fig. 21. Furrow openers of the zero-till drill-cum-bed planter.

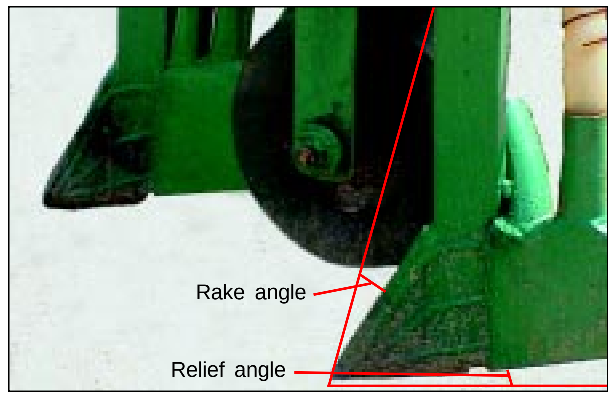

Fig. 22. Rake angle and relief angle of the furrow opener.

directly with clamps. The “bolted on” blades can be replaced by farmers whereas “welded on” blades will require machine shops to replace them. The “weld on” openers are replaced with “knock out” type openers which are easy to replace. Double boot is provided behind each furrow opener to receive a tube each from seed and fertilizer metering devices. These furrow openers make 3–5 cm wide and deep slit. The depth of seeding can be adjusted by raising or lowering the depth-control side wheels. It can also be adjusted (independent of the depth-control side wheels) by raising or lowering the shanks of the furrow openers. The machine can be properly leveled by three-point linkage.

Ridger and Bed-cum-furrow Shaper

Ridger and bed-cum-furrow shaper (Fig. 20b) have been combined together and mounted at the front bar of the frame. The length of the

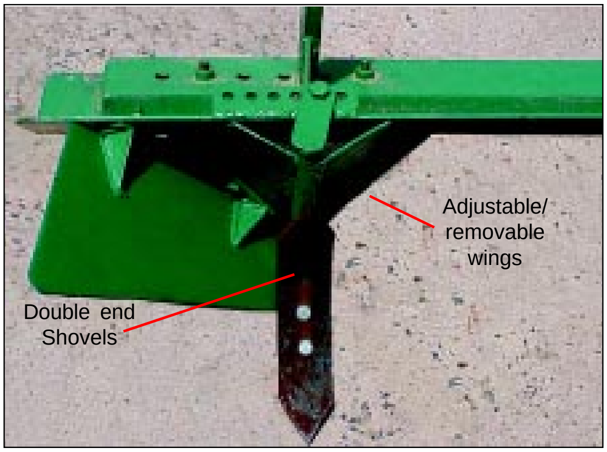

Fig. 23. Ridger, bed-cum-furrow shaper fitted with double end shovel

bed-cum-furrow shaper is 200 cm, while the width of the bed-maker is 36 cm. Double end shovels (Fig. 23) (three in number) of 7 cm width at a distance of 60 cm have been provided with bed-cum-furrow shaper to open the furrow. Triangular furrows with 30 cm top width and depth each are made with this shaper. However, the bed width and furrow depth are adjustable. If the central shovel is removed (Fig. 20b) it is possible to have wider beds of one meter width which are good for nursery raising or crops requiring wider spacing. Shaper or ridger (Fig. 24) can be detached when this machine is to be used as zero-till seed-cum-fertilizer drill. Whereas the shaper should be attached in front of the openers with the machine when it is to be used as a bed planter. Additionally, when it is in use as a bed planter, furrow openers should also be adjusted

Fig. 24. Ridger of the zero till drill-cum-bed former.

Fig. 25. Wings of ridger

by removing or raising few furrow openers with shanks according to the number of rows and spacing in different crops to be raised on the top of the raised beds.

In some machines ridger and shaper/ packing rollers have been provided separately. Three ridgers (Fig. 20b) have been provided to make two beds in a single pass. But most of the farmers have tractors in the range of 35-45 HP and 3 ridgers can easily be pulled by these tractors. Height of the beds in wheat varies from 15 to 30 cm and it can be further adjusted. Whereas the width of furrow and top of the bed generally remain 30 cm and 37 cm, respectively. However, it can be varied from 20 to 40 cm by adjusting the wing width (Figs. 23, 25).

Seed and Fertilizer Boxes

The seed and fertilizer boxes (Fig. 26) of the drill are made up of mild steel sheet (2 mm thick). The seed box is on the rear side and the fertilizer box is towards the front side. However,

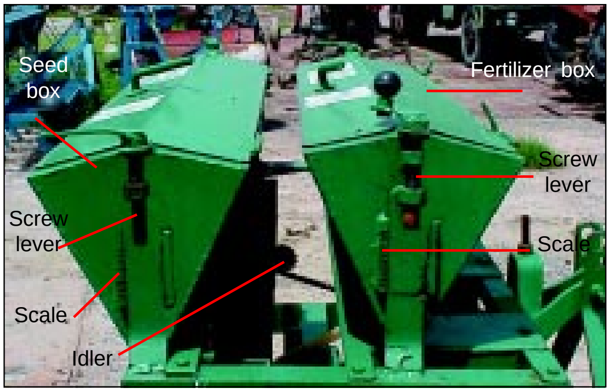

Fig. 26. Seed and fertilizer boxes

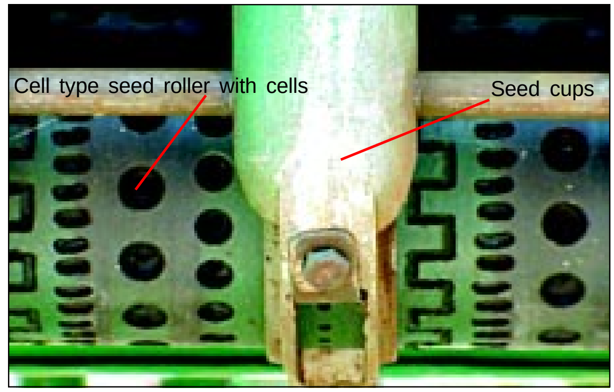

Fig. 27. Cell type roller and seed cup.

both are attached side by side and are of trapezoidal shape. The overall length of the fertilizer and seed boxes is 145 cm with a total depth of 28 cm. However, the length of fertilizer and seed boxes will vary with the coverage width of the machine. The capacity of the above fertilizer and seed boxes is sufficient to hold 50 kg DAP and 50 kg wheat seed at one time, respectively. The seed box as well as the fertilizer box can be adjusted up and down with the help of screw levers to control the seed and fertilizer rate with the help of scale affixed to each box (Fig. 26).

Seed Metering Device

Cell or drum type metering system (Fig. 27) has been provided with cells of different sizes to be used for sowing of different crops of various seed sizes. A rubberized roller of 90 mm diameter and 118 mm length has been mounted on a cast iron roller of 77 mm diameter. The number of cells cut on the periphery of roller are 32 (3 mm diameter), 32 (5 mm diameter), 20 (10 mm diameter), 14 (12.5 mm diameter), 39 (10 × 4.5 mm oblong) and 30 (9 × 13 mm zigzag) which can be selected for crops of different seed size and shape. The cell selected should be in the centre of cup (Fig. 28) provided for dropping the seed to seed tube. The number of seeds picked up by cells can be varied by raising or lowering the seed box with the help of screw lever (Fig. 26) mounted on both sides of the box and with this, the level of seed in the seed cup can be reduced or increased by lowering or raising the

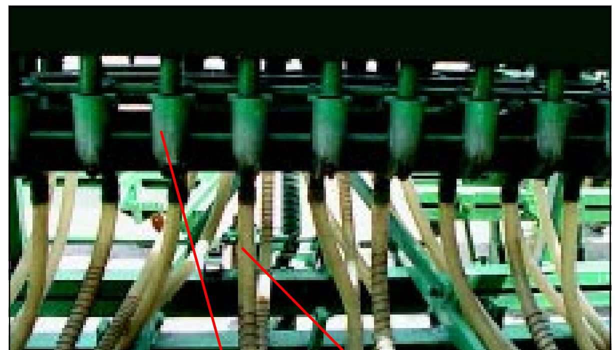

Fig. 28. Seed cup with plastic tubes.

box, respectively. Seed rate can also be varied by changing the sprocket attached to the drive wheel. Knockout brushes and seed cell selection lever are two important components of seed metering device. The newly designed seed metering device has the advantage that most crops can be handled precisely with it.

Brush: Knockout brushes (Fig. 29) have been provided on the top of cups mounted on roller

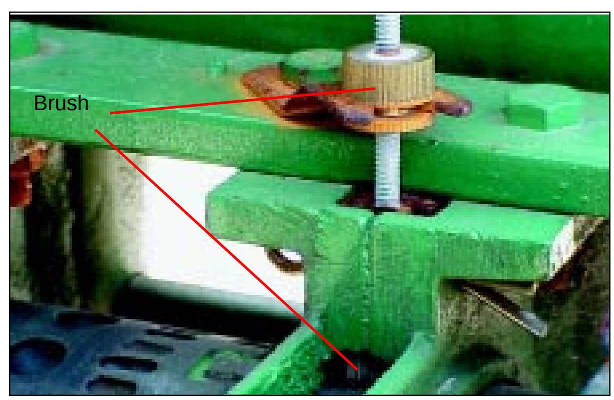

Fig. 29. Knockout brush

just to remove extra seeds sticking with each other.

Seed cell selection lever: Seed cell selection lever (Fig. 30) has been provided to move the roller and the desired cell according to seed size and shape which can be selected before seeding.

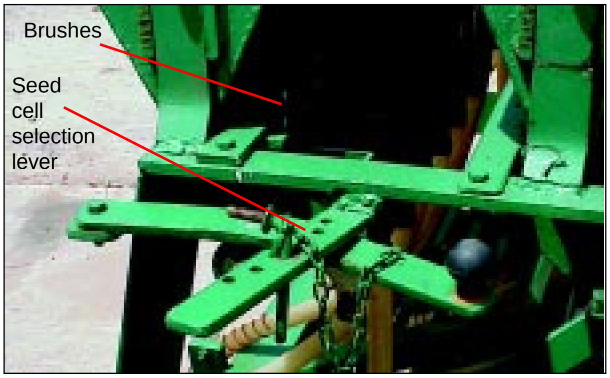

Fig. 30. Seed cell selection lever

Fertilizer Metering Device

The cell type fertilizer metering device has four separate compartments made up of mild steel sheet and in each compartment three cell plates/rollers (Fig. 31) are provided at the bottom of fertilizer box. The quantity of the fertilizer is varied by maintaining the level of fertilizer in the cell plate compartments which is regulated by raising or lowering the fertilizer box with the help of screw lever (Fig. 31) provided at both sides of the fertilizer box. Further improvement has been made in the metering device to use urea as such or in the form of granules/pellets.

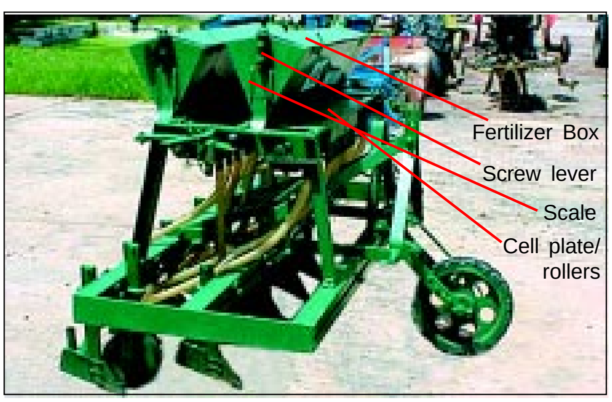

Fig. 31. Fertilizer metering device and its components.

Power Transmission Unit

Power transmission unit and its components have been sown in Fig. 32. Power from lugged ground wheel/drive wheel (Fig. 33) can be transmitted to a shaft (1:1 and 1:1.5 or vice-versa) mounted on the frame. From this shaft, power is transmitted to seed and fertilizer metering shafts through chain and sprocket (Fig. 34) arrangement in the ratio of 3:1, 2.25:1, 2:1, 1.5:1 to the fertilizer shaft, whereas to the seed metering shaft in the ratio of 1:1, 1.5:1 and 2:1. An idler sprocket (Fig. 35) has been provided to tighten or loosen the chain for its smooth running.

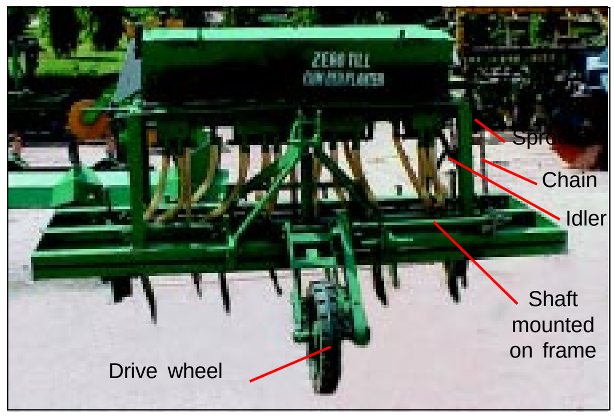

Fig. 32. Power transmission unit and its components.

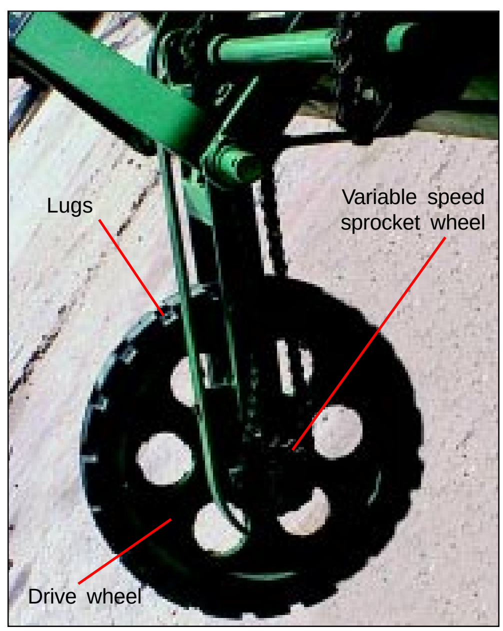

Fig. 33. Drive wheel

Fig. 34. Chain and sprocket in different ratios to vary the power.

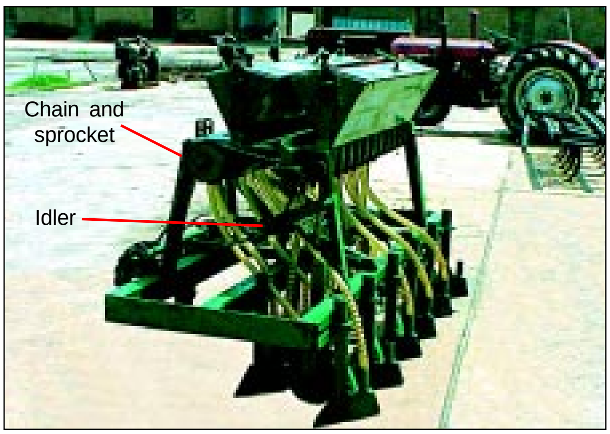

Fig. 35. Idler sprocket

Hitch Points

The zero till-cum-bed planter has a standard hitch point system (Fig. 36).

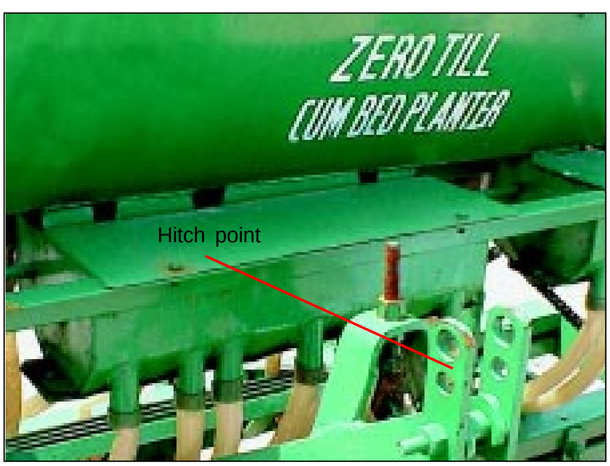

Fig. 36. Hitch points.

Iron/wooden Platform or Stand

An iron or wooden platform/stand (Fig. 37) is also attached on rear side of the frame. One person can either stand or sit on this platform while machine is in operation just to ensure that seed and fertilizer are running properly through respective plastic tubes without any blockage.

Fig. 37. Iron/wooden platform or stand

Depth-control Side Wheels

Two wheels (one on either side of the machine) each of around 20 cm diameter made up of mild steel plate or rubber have been provided to get the required seeding depth when this machine is used as zero-till drill. These depth-control side wheels (Fig. 38) can be raised and lowered with screw bolts to adjust the seeding depth. When the machine is to be used as a bed-planter, the wheels may be either raised or removed.

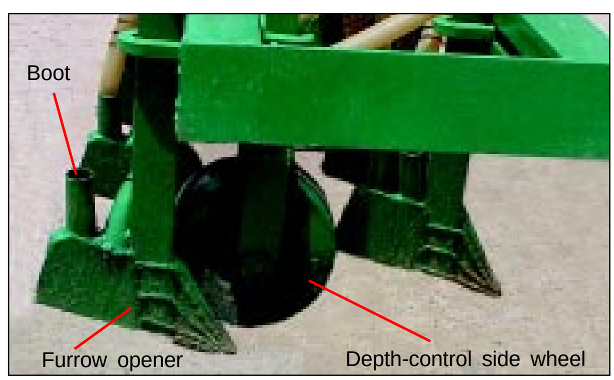

Fig. 38. Depth-control side wheel.

Interculture Tines

Interculture tines (Fig. 39) with boots have been provided which can be fitted on frame as and when there is need for mechanical weeding and urea application/topdressing between two rows of a crop and on both sides of the raised bed. At the time of mechanical weeding, furrow openers used for seeding and furrow-cum-bed shaper/packing rollers are removed. But ridgers remain attached, which can be adjusted inward if needed (to keep outer rows from damage), during mechanical weeding to control weeds particularly in furrows.

Fig. 39. Interculture tines

Precautions for Use

In addition to the 'Precautions for use' given in the section relating to zero-till seed-cm-fertilizer drill, the following precautions may also the kept in mind for using the bed planter.

- Field should be leveled and well prepared before making beds.
- Beds are made well in advance and field irrigated to encourage germination of weeds before sowing and then germinated weeds can be controlled either mechanically by reshaping the beds or during sowing operation or with the spray of non-selective herbicide glyphosate (Round up/Glycel, 41% SL) @ 1.0% solution before sowing. As such, resistant *Phalaris minor* (kanki/mandusi) in rice-wheat cropping sequence and broad leaf weeds in sandy or sandy loam soils with other crop rotations can easily be controlled.
- Do not allow drying up of the upper soil layer before sowing otherwise seed will have to be placed deep and it will affect germination.
- Mechanical weeding or interculture with this machine (after making minor alterations in the position of its tines) is possible in the standing crop, if it has been sown in two rows/bed. There can be intercultivation just in the furrows, in case of 3 rows/bed.
- Special care should be taken regarding depth of seeding; otherwise there may be problems in germination.
- Attack of termites may be another problem in sandy areas; hence, special attention or precaution should also be taken in this regard.
- Sometimes due to imbalance of machine attached with tractor or present shape of wings of ridger, soil layer on one side top of alternate beds is formed which may hamper seed germination. So care should be taken by the farmers to balance the machine to remove this soil layer or to modify the wings by getting these cut at outer edges.

IV. Tips for Manufacturers, Operation, Maintenance and Repair

For Manufacturers

- Machine should be of good quality and manufactured according to appropriate design specifications/drawing.
- Frame shanks and furrow openers should be strong and made of proper material.
- Provision should be made for replaceable parts on wear and tear.
- There should be stress-free and proper alignment of components without any inbuilt stress assembly.

- Testing before marketing should be ensured at manufacturer level.
- Spare parts, critical components, nuts and bolts or clamps should be of high strength and standard quality.
- Minimum tool kit should be provided.
- Packing, handling and transportation should be proper.
- Pooled service should be provided free of cost for replacement of parts or complete machine, if there is any defect or breakage during transportation.
- Manufacturer should incorporate required modification based on feed back from time to time.

Planting Operations

Following points must be kept in mind before actual planting operation:

- Seed should be of good quality and free from dirt and dust.
- Fertilizer should not have clods. Clods should be properly broken to uniform size for free flow of fertilizer.
- All the nuts and bolts, rollers and springs should be thoroughly checked, defective parts should be replaced and nuts/bolts properly tightened.
- Seed and fertilizer boxes, flutted rollers, fertilizer metering shaft and controlling bottom plate (having triangular holes) should be thoroughly cleaned.
- Flutted roller shaft should move freely, otherwise the rollers may be broken.
- Feed cups should be thoroughly cleaned and obstruction if any, must be removed.
- Ensure that plastic pipes do not have excessive bend. This will block the free flow of seed and fertilizer in tubes.
- Chain sprocket of metering mechanism should be properly aligned. Appropriate tension in the chain may be kept for free movements of seed and fertilizer metering shafts. If there is any noise during operation, stop the machine and check it.
- Furrow openers should be fitted on the frame according to the requirement (row to row distance) of the crop. There should be no crossing or twisting of furrow openers.
- Fill the seed and fertilizer boxes and calibrates the machine. Ensure that seed drill is set at desired seed and fertilizer rates. This will ensure proper metering of seed and fertilizers and result in excellent germination, good crop stand and higher yield.

Maintenance and Repair

A well maintained and properly adjusted seeding machine gives trouble free service for a long time. It also helps in timely completion of operations The following important points may be kept in mind for the maintenance and repair of various components of the seeding machines.

A. Seed and Fertilizer Boxes

The boxes should be thoroughly cleaned as these may rust very fast due to environmental moisture. This will damage the boxes and machine will not be useful for the next crop sowing season. The boxes must be cleaned as under:

- Raise the machine above ground so that the drive wheels move freely
- Remove seed and fertilizer from boxes.
- Open the flow gates of seed and fertilizer cups.
- Rotate the drive wheel till the seed and fertilizer from different seed and fertilizer cups are emptied. Clean the boxes and cups with the help of a cloth or brush.
- Wash the machine rollers/seed/fertilizer boxes with diesel to avoid rusting.
- Apply lubricating oil at appropriate places (bushes and sides of metering rollers).

B. Drive/power Transmission System

For maintenance of drive system/power transmission system, keep following points in mind:-

- Drive wheel should move freely. If it is jammed, then apply grease or put oil in its bushes. If axle of wheel is bent or worn out, replace it.
- Drive wheel should be round, if it is bent then repair it.
- Sprockets of drive wheel and feed shafts (seed and fertilizer boxes) should be properly aligned.
- All sprockets should be properly tightened on their shafts so that these may not move freely on these shafts.
- Feed shafts should move freely. If these are jammed due to rusting,, then clean and apply lubricating oil/grease in the bushes.
- Bent drive shafts should be repaired or replaced.
- Seed and fertilizer boxes should be thoroughly cleaned for free movement of feed shafts.
- Chain and idler sprocket should be properly tightened so that proper chain tension is maintained and mechanism moves freely.
- Worn out parts, loose, broken and worn out bushes should be replaced.

C. Seed Metering Mechanism

Usually flutted roller type seed metering mechanism is used in these seeding machine. It should be repaired and maintained as under.

- Side plate of seed metering shaft sprocket should be removed by loosening nuts/ bolts.
- Remove the nuts/bolts of all the seed cups.
- Remove pins of all the flutted rollers.
- Remove metering rollers from the seed cups and replace broken rollers and notched plates.
- Take out the shaft on one side. All rollers will come out of seed cups.
- During refitting of rollers, it must be ensured that all the rollers are at equal distance in the seed cups. If distance is different, then put varcels (washers) to achieve equal distance.
- Put the rollers on the shaft and put again on the seed box.
- Complete system should move freely and rotate the sprocket till appropriate seed rate is achieved from all the rollers.

D. Fertilizer Metering Mechanism

In fertilizer metering mechanism, fertilizer settles on its parts due to environmental moisture which may cause obstruction in free and uniform flow of fertilizer. Large particles also cause hindrance in the mechanism. In some of the seeding machines, adjustable triangular holes with agitator are provided for fertilizer metering. Therefore, this system requires special attention as follows:

- After seeding a crop, fertilizer should be removed from the box and whole system should be cleaned with the help of brush or cloth.
- If the system is jammed due to corrosion and rusting, the lower plate having triangular holes must be removed and cleaned with kerosene or diesel.
- All the holes in the box should be properly open.
- Agitators provided on the shaft should also be cleaned and the lubricating oil/grease may be applied in the bushes of the fertilizer metering shaft.
- Lever for adjustment of fertilizer rates should move freely.
- Tighten all nuts and bolts of the mechanism.

Likewise in other seeding machines which possess rotating cup type metering device should also be cleaned carefully. Each compartments, cup/cell and funnel should be free from jamming and the roller should move freely.

E. Seed and Fertilizer Tubes

These are mostly plastic tubes connected to seed/fertilizer cups and their lower ends are connected to seed boots.

- Tubes should be connected to seed/fertilizer cups with the help of clamps so that these may not come out during field operation.
- Tubes should be protected from bending and breakage.
- Old/bent tubes should be replaced.
- Excessive bend in the tubes should be avoided otherwise the bend will cause obstruction in free flow of seed/fertilizer and results in non-uniform application of fertilizer in the field.

F. Furrow Openers

Furrow openers are attached to main frame with the help of nuts/bolts. The furrow openers wear out or twist very fast. Therefore, these should be repaired frequently. The worn-out ones should be removed/replaced as and when required.

G. General

- All the components of the machine should be painted
- Machine should be protected from rain, dirt and dust etc. during its storage.
- Moving parts should be greased/oiled at regular intervals so that the machine gives a trouble free service for a long time.
- Users training will lead to improvement in the performance of the machines.

Annexure I

List of Manufacturers

1. A.S.S. Foundary and Agricultural Wroks, Jandiala Guru, Amritsar, Punjab
2. National Agro Industries, Ludhiana, Punjab
3. Kamla Engineering Works, Ismailabad, Kurukshetra, Haryana
4. Laxmi Agriculture Engineering Works, Kaithal
5. Ashoka Farming and Engineering Works, Shabad Markanda, Kurukshetra, Haryana
6. Narwal Engineering Works, Shabad Markanda, Kurukshetra, Haryana
7. Viswa Karma Engineering Works, Tohana, Fatehabad, Haryana
8. Guru Nanak Krishi Udyog, Pehowa, Kurukshetra, Haryana
9. Guru Nanak Khalsa Engineering Works, Pehowa, Kurukshetra, Haryana
10. Kadian Engineering Works, Kaitahal, Haryana
11. Malwa Agriculture Engineering Works, Tohata, Fetehabad, Haryana
12. M/s Jhandu Engineering Works, Ambala, Haryana
13. Guru Nanak Foundry and Engineering Works, Kaithal, Haryana
14. Super Agricultural Industries, Karnal, Haryana
15. Beri Krishi Udyog, Karnal, Haryana
16. Darshan Singh Agri. Works, Karnal, Haryana
17. Pyara Singh Agri. Works, Karnal, Haryana
18. Bharat Agricultural Industries, Karnal, Haryana
19. Sarswati Krishi Udyog, Karnal, Haryana
20. Punni Agricultural Engineering Works, Fatehabad, Haryana
21. Sukhvindra Agricultural Works, Talwandi, Punjab
22. Panishar Agricultural Works, Amargarh, Punjab
23. Malwa Agro Industries, Ludhiana, Punjab
24. Doaba Agricultural Works, Sitarganj, U.S. Nagar, Uttaranchal
25. Tyagi Agro Industries, Kitcha, U.S. Nagar, Uttranchal
26. Hans Engineering Works, Suraj Kund Road, Phool Bagh Colony, Meerut, U.P.

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I. Paper Series

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Rice-Wheat Consortium for the Indo-Gangetic Plains

The Consortium is an Ecoregional Program of the Consultative Group on International Agricultural Research (CGIAR), managed by CIMMYT, involving the National Agricultural Research Systems, the International Agricultural Research Centers, and the Advanced Research Institutions. Its main objective is to promote research on issues that are fundamental to enhance the productivity and sustainability of rice-wheat cropping systems in South Asia.

These objectives are achieved through:

- Setting priorities for focused research on problems affecting many farmers.
- Promoting linkages among rice-wheat research specialists and other branches of research and extension.
- Encouraging interdisciplinary team approach to understand field problems and to find solutions.
- Fostering quality work and excellence among scientists.
- Enhancing the transfer of improved technologies to farmers through established institutional linkages.

Financial support for the Consortium's research agenda currently comes from many sources, including the Governments of Australia, Netherlands, Sweden, Switzerland, and the Department for International Development (DFID), the International Fund for Agricultural Development (IFAD), the United States Agency for International Development (USAID), and the World Bank.

Rice
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