Advancing Sustainable Agriculture: Cutting-Edge Resource-Conserving Sowing Operation

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Introduction

The ongoing degradation of natural resources and climate change present significant challenges to researchers striving to boost crop productivity on diminishing land. Key issues such as groundwater depletion, soil health decline, and erratic rainfall patterns are particularly severe in dryland agriculture, were limited moisture hampers crop growth. Delays in field operations, improper seeding depth, and poor crop residue management contribute to reduced yields and profitability. Adopting resource-conserving technologies like strip-till drill, turbo happy seeder, planter cum herbicide applicator, pneumatic planter and raised bed planter can lower fuel costs, reduce air pollution, and improve farmers' net profits while conserving water and energy.

Strip-Till Drill

The Strip-till drill is a PTO-operated implement for direct seeding, featuring 'J'-type blades for targeted tillage in narrow strips, enhancing seed-soil contact and germination (Fig. 1). It serves as a middle ground between conventional and zero tillage, offering better seed germination without full soil coverage. Studies have shown its benefits, including higher yields in various cropping systems, improved plant density, reduced soil temperature, increased moisture conservation, and enhanced soil organic carbon, making it an effective option for conservation tillage in diverse agricultural conditions (Jaskulska *et al*., 2018).

Fig. 1 Strip-Till Drill planter

Turbo Happy Seeder

The Turbo Happy Seeder (THS) is an upgraded version of the Happy Seeder, designed to work efficiently in heavy straw conditions with reduced energy demand (Fig. 2). It features inverted 'γ'-type flails on a rotor within a straw management drum, which shear stubbles and smash residue against serrated blades for fine chopping. The THS reduces dust and leaves sowing rows exposed. Studies show it improves wheat yield compared to straw burning followed by tillage, reduces fuel use, ensures optimal sowing timing, and decreases irrigation needs. However, higher weed infestation is reported with conventional methods compared to zero tillage and THS (Singh *et al*., 2020).

Fig. 2 Field Operation of Turbo Happy Seeder

Planter cum Herbicide Applicator

Fig. 3 Field Operation of Planter cum Herbicide Applicator

Timely weed control is crucial for optimal yield, with herbicide application being the most

popular method (Fig. 3). Pre-emergence herbicides are key in conservative farming, controlling early-stage weeds and reducing the need for post-emergence herbicides. Combined seeder/ planter-herbicide applicators enable simultaneous sowing and weed management.

Pneumatic Precision Planter

A pneumatic-type seed metering mechanism offers high precision in seed placement, minimal seed damage, precise depth control, and uniform intra-row plant spacing (Fig. 4). It works on a suction principle, where air is sucked through a rotating plate with equidistant holes, capturing seeds that fall when suction is cut off near the ground. This system is suitable for various seed types, including non-uniform seeds, and ensures exact planting of single seeds with synchronized spacing. Although it requires high-quality seeds for optimal performance, it reduces labor demand, which is crucial as skilled labor availability declines (Mandal *et al*., 2018).

Fig. 4 Field operation of Pneumatic Precision Planter

Multi-Crop Raised Bed Planter/Broad Bed Furrow (BBF) Planter

Crop productivity in rainfed farming is often low due to limited soil moisture. To address this, appropriate machinery like broad bed furrow planters (Fig. 5) can be used to conserve rainwater in situ, ensuring sufficient moisture throughout crop growth stages. These planters facilitate simultaneous preparation of broad bed furrows and sowing, offering benefits such as water savings, mechanical weeding, and improved plant stand. Studies report better grain quality, increased yield, improved nitrogen use efficiency, and reduced irrigation costs with raised bed systems compared to flat sowing. Trials with tractor-operated raised bed planters have shown enhanced moisture conservation, yield, and lower energy requirements (Kumar *et al*., 2013).

Fig. 5 Field operation of multi-crop raised bed planter

Conclusion

Advancing sustainable agriculture requires innovative, resource-conserving sowing operations like the Turbo Happy Seeder. These cutting-edge technologies enhance crop yield, reduce fuel consumption, and preserve soil health while minimizing environmental impacts. By adopting such practices, we can achieve long-term agricultural sustainability and food security.

References

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