Aerobic rice mechanization: techniques for crop establishment

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Abstract. Rice being the staple food crops, hundreds of land races in it makes the diversity of rice crops. Aerobic rice production was introduced which requires much less water input to safeguard and sustain the rice production and conserve water due to decreasing water resources, climatic changes and competition from urban and industrial users. Mechanization system plays an important role for the success of aerobic rice cultivation. All farming activities for aerobic rice production are run on aerobic soil conditions. Row seeder mechanization system is developed to replace conventional seeding technique on the aerobic rice field. It is targeted for small and the large scale aerobic rice farmers. The aero - seeder machine is used for the small scale aerobic rice field, while the accord - seeder is used for the large scale aerobic rice field. The use of this mechanization machine can eliminate the tedious and inaccurate seeding operations reduce labour costs and increases work rate. The machine is easy to operate and it can increase crop establishment rate. It reduce missing hill, increasing planting and crop with high yield can be produce. This machine is designed for low costs maintenance and it is easy to dismantle and assemble during maintenance and it is safe to be used.

1. Introduction
To achieve higher self-sufficiency level (SSL) required for food security rice yield need to be increased rapidly by increasing the rice production areas. Major challenges to meet the objectives are short of natural resources such as suitable lowland, insufficient water supplies throughout growth period and lack of labour force. Rice is one of the few crops cultivated under flooded conditions. The process of cultivation of rice requires huge amount of water as well as long working hours. According to an estimate it requires approximately 5000 litres of water to cultivate 1 kg of rice [1, 2].

Conventionally, there are two methods to cultivate rice i.e. sowing method and menugal method. In sowing method, the farmers and/or labourers sow the seeds manually on a prepared ground for sowing. This method requires lanes for manual sowing and needs 200 hrs/ha of man/labour hours. Further, said method is only suitable for small-scale area and cultivation of rice in a large-scale area i.e. more than 1 ha is not possible with this method [3].
The menugal method is an improved method as compared with the sowing method. However, unlike sowing method it requires a large amount of water as well as substantial amount of man/labour hours to cultivate rice. In this method, farmers and/or labourers sow the seeds into the soil by using a dibble and requires 92.30 hrs/ ha of man/labour hours for an area of 1 ha. Though this method may be used to cultivate a large-scale area, however, due to substantial amount of time and high dependency on skilled labourers this method is not suitable for the same [4].

However, such aforesaid technologies/methods possess following limitations and/or disadvantages. First and the foremost requirement of conventional method is the need of highly skilled workers for sowing seeds which leads to high production cost. Further, the conventional methods are tedious and require very hard work. The conventional methods require a huge amount of water for cultivating rice. Water being a limited natural resource, the conventional methods over - exploit the ground water. In addition, the conventional methods are time consuming and incapable of carrying out rice cultivation in a large-scale area i.e. more than 1 ha. Also, sowing of seeds is not accurate by the conventional methods which hamper the final quantum of crop produced at the time of harvesting.

A lot of research and development has taken place in this regard for having an alternate method of cultivating rice. Aerobic rice crop cultivation is one of the improved methods [2] known wherein cultivation of rice is carried out under aerobic situation. In the aerobic crop cultivation method, the farmers are not required to grow rice sapling separately in a nursery and it also eliminates the need of ploughing the land. The farmers, by using the seed drill pulled by tractor or bulls, can sow the seeds directly in the land. Further, by using the aerobic crop cultivation method, paddy can be sown with good spacing in between and prevented from developing any disease as well as the yield as compared with conventional method. The aerobic crop cultivation method requires less labour, less human intervention and less quantity of seeds, therefore is economical as compared with the conventional methods. However, existing aerobic cultivation systems/methods include number of limitations and shortcomings.

Accordingly, there remains a need in the prior arts to have an improved method of cultivation of crop especially rice with an aero - seeder machine which enables the cultivation of crops in a sustainable manner which in turn increases crop establishment rate. Further, it can reduce the amount of land which remains left out during manual cultivation of crops and increases yield of the crop. Aerobic rice planting is fundamentally a different approach of rice cultivation proposed by MARDI to overcome this issue where a high yielding rice variety is grown in non-puddled and non-saturated fields with supplementary irrigation and high external inputs [5]. Mechanization system plays an important role for the success of aerobic rice production. The development of machine that efficient to help aerobic rice farmers is needed to achieve the mission of the aerobic rice production in this country. A modern agricultural practice emphasizes the ability of farmers to meet that demand of the consumers of rice. The development of mechanization system of row seeding machine is one way to increase the efficiency of the farm work, while reducing dependence on labour and also to create a method of rice cultivation more systematically. Row seeding mechanization systems for aerobic rice have been developed by MARDI to help maximize the profitability of the farmers. This will ensure the completeness of seeds cultivation operations to be more accurate in terms to get a better crop yield and quality result [6].

2. Materials and Methods-Accord-seeder
Embodiments of the present invention aim to provide an aero - seeder machine which replaces the conventional seeding techniques of cultivation of rice. The proposed machine is suitable for small as well as large scale area. Further, aero - seeder machine eliminates the tedious and inaccurate seeding operations carried out by labourers manually. The aero - seeder machine is easy to operate and it can increase crop establishment rate. Also it reduces missing hill and increases cultivation, thereby crop with high yield can be produced. Embodiments of the present invention are made possible in this way:

An aero - seeder machine comprises a frame, a plurality of sliding shaft mounted on the frame, a plurality of seed hopper mounted on the plurality of sliding shaft and configured to carry a plurality of
seed, a plurality of metering device mounted on the plurality of sliding shaft and configured to attach at a bottom end of the plurality of seed hopper, a plurality of seed hose cone mounted on the plurality of sliding shaft and configured to couple at the bottom end of the plurality of seed hopper, a plurality of drop hose configured to couple at a bottom end of the plurality of seed hose cone, a plurality of furrow opener attached with the frame and configured to construct a plurality of row seed lane on a ground and a plurality of wheel coupled with a proximal end of the frame. Where in the frame is attached with a two wheeler tractor. The plurality of seed hose cone drops the plurality of seed in the plurality of drop hose and the plurality of metering device regulates the amount of plurality of seed flows from the bottom end of the plurality of seed hopper. Thereafter, the plurality of drop hose drops the plurality of seed inside the plurality of row seed lane which is having depth in the range of 0.03 m to 0.05 m and the plurality of wheel closes the plurality of row seed lane.

As compared to the existing technologies, the proposed machine is economical as it has low maintenance costs, easy to dismantle and assemble during maintenance, reduces labour costs and increases work rate.
Accord seeder machine is used for the large scale area for aerobic rice. The machine is attached to the four wheel tractor and pneumatic systems used for dropping the seeds. The central metering device accurately measures any desired volume of seed from 2 kg/ha to 200 kg/ha. For the sowing of aerobic rice, the metering device can be infinitely adjusted to fine seed/micrometering by means of a spindle, without any need for tools.

The central, totally enclosed cell wheel of the metering device accurately measures the required volume of seed and discharges it into the venturi cone where it is mixed with the air stream and then conveyed through the diffusor tube and the seed delivery hoses to the coulters. Distribution installed in a protected position in the seed hopper. Advantages using of this machine is the machine easy to be adjusted, the hopper is placed close to the tractor and have a wide breadth of the sower which is up to 1.5 - 3.0 meters for sowing seeds in the large-scale area.

Table 1. Specifications and functions of the row seeder.

| Aero – seeder                      | Accord - seeder                      |
|------------------------------------|--------------------------------------|
| Equipped 6 row seeder hose         | Equipped 9 row seeder hose           |
| Seed rate 80-150kg/ha              | Seed rate 60-150kg/ha                |
| Work rate 3-4 hour/ha              | Work rate 1-1.5 jam/ha               |
| Work rate/day (2 ha/day)           | Work rate/day (6-7 ha/day)           |
| Attached to 2 wheel tractor (power tiller) | Attached to 4 wheel tractor 40hp above |
| Hopper capacity 6kg/tank (machine equipped with 6 hopper) | Hopper capacity 150-200kg/tank |
| Seed drop by gravity flow          | Seed drop by pneumatic air flow system |

3. Results And Discussions

Conventional sowing method and the menugal method is only suitable for small-scale area. This method is not practical for a large-scale area of more than 1 ha. This is because the conventional method requires a lane for manual sowing and it requires the work of 200 hours hour/ha, while the method of mech – tugal required working hour 92.3 hours/ha for an area of 1 ha. This method is very detrimental to the time and high dependence for labour required on the large scale area.

Compared to mechanization system of row seeder, time and dependence on labour can be saved and reduced by more than 50%. For the use of aero - seeder machine, sowing the seeds for the area of 1 ha take time to work 3-4 hours / ha, while the use of accord – seeder machine, time work for an area of 1 ha area is 1-1.5 hours / ha. Therefore, the economic impact of the use mechanization system of row seeder for aerobic rice farming is more economical. In addition besides reducing dependence on labour, it also enhances work efficiency. Mechanized system of row seeding also enhances aerobic rice seed bed for good crop growth and uniformly planting line.
4. Conclusions

Aerobic rice mechanization system is urgently needed to ensure that agricultural activities can be cultivated intensively and effectively and provide returns to the farmers and make a meaningful contribution to national food production.

The potential of growing aerobic rice is good when it can be grown as upland crop while saves water. Thus, in areas where water is relatively scarce than land, the best way to maximize total rice production is by growing aerobic rice. However, the level of mechanization operations should be as good as wetland land rice cultivation if not better. This is to ensure farming activities can be carried out without depending heavily on labour force and water can be supplied to the field in the right time, right amount and right place. By using row seeder for Aerobic rice production, labour dependency problems can be solved and working time can be reduced compared with the work of conventional sowing. Therefore, it is recommended to use the mechanization of the row seeder to increase rice yield besides improving the quality of aerobic rice production and farmers work quality.

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