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Mechanization of selected operations in puddled condition for increasing rice profitability

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ABSTRACT

Due to climate change and uncertainty in rainfall causes delay in field preparation, sowing, weeding and harvesting results in diseases and pest attack & reduction in yield. Of different field operations, sowing weeding and harvesting together consume major labour force and if these are managed timely and efficiently by the farmers, could earns good profit. To access the performance of machines used in cultivation of rice an experiment was conducted at Krishi Vigyan Kendra, Kanker. For line sowing in wet condition with an eight row paddy drum seeder, weeding with a weeder and a self-propelled paddy reaper for harvesting of rice was evaluated in the study. Selective mechanization of rice crop helped in line sowing of crop with drum seeder results in 18.40 per cent higher yield also saved costly seeds 57.18 per cent compared to broadcasting manually. The cost of mechanical weeding with Ambika paddy weeder was Rs 1296 ha^{-1} as compared to hand weeding of Rs 2349 ha^{-1} and involved saving of 14 man days. Mechanically harvesting can not only reduce the cost by 57.98 per cent but also saved 15 man days compared to manual harvesting respectively. Thus, mechanization in rice cultivation is feasible solution for reducing the cost of sowing, weeding and harvesting of rice crop without any yield reduction.

Keywords : Ambika weeder, drum seeder, mechanization, puddled

Among the rice growing countries, India has the largest area under rice in the world, accounting for about 31 per cent of the total area (42.2 million hectares) under rice cultivation producing about 84.74 million tons of rice annually. The area of directed rice in India is 7.2 m ha (Anonymous, 2011). Paddy is the principal crop and the central plains of Chhattisgarh are known as rice bowl of central India, which is having area under *kharif* rice on 37. 93 lakh ha with total production of 6.028 metric tonnes (Anonymous, 2011). Most of the farmers grow rice by tradition methods and is a labour intensive crop. About 850-900 man-hr required for one hectare of rice cultivation. High labour requirement during peak periods increases the cost and labour for rice cultivation (Fig. 1) (Singh, V *et al.*, 2012).

The traditional methods of growing rice involves dry seeding, in which seeds broadcasted in prepared field followed by ploughing with desi plough or cultivator. In lehi method, is to sow pre-soaked sprouted seed (soaked for twenty four hours and incubated for forty-eight hours), at 80 to 100 kg ha^{-1}, broadcasted manually in puddle field. Most widely adopted method by transplanting of seedlings under puddle conditions. It is preferred over other methods with the reason that this method gives better yield and there is less weed infestation. This method is very tedious and labour intensive operation. Approximately, more than 25 per cent of the total working hours for rice production are spent for the process of transplanting and raising nursery. The average plant population of manually transplanted rice has been reported much less than the required one. However, transplanting takes about 250-300 man-hrs ha^{-1} which is roughly 25 per cent of the total labour requirement of the crop (Chaudhary, *et al.*, 2003).

Often the farmers face the problem of shortage of labours during the peak transplanting season due to which timely rice transplanting is very difficult. It has been reported that delay in transplanting by one and two months has a yield reduction of about 25 to 70 per cent, respectively. Due to late transplanting the turn-around time available for the next crop is very small which again affects the yield of the subsequent crop. The following gives the operation wise labour requirement in rice cultivation (Manjunath, *et al.*, 2009).

Weeding in paddy is timely operation to be executed to get maximum yield otherwise weed will compete for the nutrients with crop. During early establishment, the weeds make 20-30 per cent of their growth while the crop makes 2-3 per cent of its growth (Moody, 1990). In rice cultivation, manually weeding is one of the time and energy consuming operation and also labour cost increasing tremendously from last decade. Hence cost of cultivation is getting increased every day. The chemical weeding is one of the effective method but it leads to various environmental and health issues. Hence there is need of low cost mechanical weeding to minimize maximize the yield.

In view of the labour shortage and the need to reduce cost of cultivation, mechanization harvesting of crop plays a crucial role. Crop harvesting is faced with lack of labour and high wages which is a major problem. On the other hand low work efficiency with manual harvesting delays harvesting operations of the rice crop. Choice of suitable harvesting method not only reduces

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production costs but also increases yield and quality produced

Keeping above facts a study was planned at Krishi Vigyan Kendra Kanker to mechanize of selected operations in puddled condition of rice crop. To evaluated the performance of drum seeder, ambika weeder and self-propelled vertical conveyer reaper for and its comparison with traditional method.

MATERIALS AND METHODS

Uttar Bastar Kanker district of Bastar region of Chhattisgarh state lies between 20° 06'20" N and 80° 40'81" E and 372 m above mean sea level. It receives on an average annual rainfall ranges between 1200-1400 mm. The study was conducted at Research Farm, Krishi Vigyan Kendra, Kanker. The experiment was planned for two consecutive year *kharif* 2014 and *kharif* 2015. The soil parameters and experimental details are shown in table 1.

Table 1: Soil and experimental parameter's during assessment

	Particulars
Rice variety	Maheshwari
Soil type	Sandy loam
Soil pH	6.5
Organic carbon	0.35
EC	0.16
N:P:K status	230:14:394
Treatments	T_1 – Selective mechanization of puddled rice plot (drum seeder, ambika weeder, vertical conveyer reaper)T_2- Farmers practice (broadcasting sprouted rice seeds, manually weeding and harvesting)
Dimensions of plot	50 x 30 m
Source of irrigation	Farm pond

Farmers practice

Rice seeds were soaked in water for 24 hours followed by incubation in gunny bags and straw for 24-48 hours depending upon the weather and temperature. The puddling was carried out with desi plough or tractor drawn cultivator and cage wheels before 18 -24 hours broadcasting. About 1-2 cm thin layer of water is maintained for 10-15 days for good germination. After 25-30 days after sowing biasi operation is done in standing crop for weeding and maintaining optimum plant population. At age of 45 to 50 days a manual weeding operation was followed for controlling weeds. After maturity of crop, manual harvesting of crop was carried out.

Table 2 : Technical specifications of manually operated paddy drum seeder

Particulars	Dimensions
Power source	Hand operated
Number of drum	4
Number of rows	8
Shape of the seed drum	Hyperboloid
Diameter of drum, mm	200
Number of holes	36
Row spacing, mm	200
Diameter of lugged drive wheel, mm	600
Diameter of the opening, mm	9
Volume weight of seed drum, gms	600
Material used	PP CP
Material of handle	GI Pipe
Operating speed, km hr^{-1}	1
Weight of unit kg^{-1}	10

Mechanical methods

Paddy drum seeder

This is a manually operated machine suitable to sow pre-germinated paddy seeds in rows. It consists of fibre drums, a metallic axle, a main frame and a handle. It is made of M.S. pipe, M.S. rod and plastics lugged wheel. The technical detail of drum seeder is given in table 2. It is hyperboloid shaped seed drum with 200mm diameter, 9 numbers of seed metering holes of 9mm hole diameter. Baffles are provided inside the seed drum between seed holes resulting in uniformity of seed rate throughout the operation. These baffles also ensure hill dropping of seeds. Each seed drum has two rows of planting. Wheels are provided at both ends having diameter is 60 cm. These wheels are made up of plastic material to provide floating characteristics and used as marker. One square shaft, handle base and handle. Four seed drums are assemble together with the square shaft. The handle if meant to pull along. The drums have holes through which seeds are dropped, while the machine is pulled backward on the prepared field.

The seeds are soaked in water for 12 hours followed by incubation in gunny bags and straw for 18-24 hours depending upon the weather temperature. The germination length of seeds should not be more than 1-2 mm to avoid any mechanical injury of pre-germinated seeds and also to ensure free flow of seeds in the drum seeder. The pregerminated free flowing clean paddy seeds are filled upto 2/3 the capacity of each seed box by opening the hinge cover. Then the covers are closed.

The machine is pulled by one man on well levelled puddle field after draining the standing water because standing water more than one cm depth disturbs the seeds sown in straight lines. The pregerminated paddy seeds are sown with the help of drum seeder in well levelled

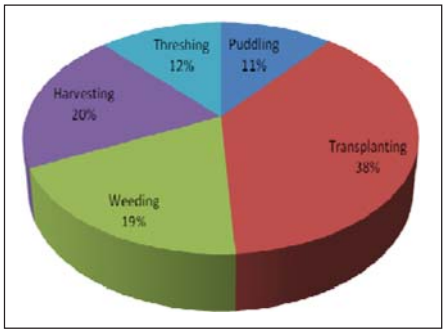

Fig. 1: Percent labour requirement for different operation in rice cultivation

Fig. 2 : Line sowing of rice in puddled field with drum seeder and crop after 30 DAS

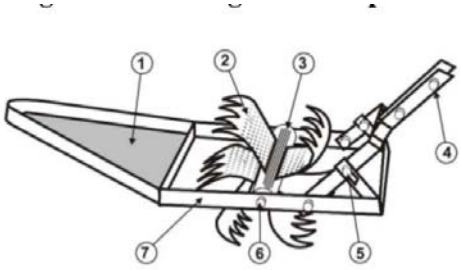

Fig. 3 : Ambika paddy weeder components and during operation in rice crop

Fig. 4 : Self-propelled vertical conveyer reaper in operation

puddle field after draining the standing water (Fig. 2). If there is more water than 1 cm then seed will float. Therefore, if there is more standing water in the fields it is better to leave the fields for 1day for settling of puddle soil. After sowing the seeds bird watching should be done for four to five days to avoid damage by birds. A thin layer of irrigation water is maintained till the seeds germinate. Once the paddy plants grow up water depth of 5-8 cm is maintained to avoid weed growth (Das, 2003). The numbers of replications were three for each treatment.

Ambika wedder

The push type ambika paddy weeder consists of serrated strips, float, main frame and handle. Strips are cut sharply in M Shape uniformly along its length mounted on round blade welded to frame (Fig. 3). The float, serrated strips and handle are joined to the frame. The float controls working depth and does not allow rotor assembly to sink in the puddle (Tayade, 2016).

Table 3 : Details technical specifications of self-propelled vertical conveyor reaper

Parameter	Specifications
Make	Kerala Agro Machinery Corporation Ltd (KAMACO), Kerala
Model	KR 120
Engine	Single cylinder 4 strokePetrol start, kerosene run
Dimensions (L × W × H)	239 × 147 × 90
Fuel & tank capacity (lits)	Kerosene-3.5 lits, Petrol-0.5 lits
Power (kW)	2.7
Weight (kg)	116
No of rows	4
Field capacity (ha hr^{-1})	0.3
No. Gears	3
Type of Cutting device	Reciprocating knife bar
Working width (cm)	120
Effective height of cutting from ground level (cm)	10
Forward speed of machine (km hr^{-1})	3.5

Mechanical harvester

A self-propelled vertical conveyor reaper is machine, which cuts the standing crop, convey the crop to one side and lay down in swath. Reaper is a rice harvesting machine which reaps crops mechanically and lays down the stems, this reaper has five dividers. Only the left one separates the crop to be cut from the uncut crop. Rice sticks coming from four guide paths are cut by the cutter bar. After cutting, the star wheel passes the crop to the conveyor chain which transfers the cut crop to the right outlet (Fig. 4). Reapers are featured by simple structure, small volume and easy operation and maintenance and can be used for wheat/rice harvest. The benefits of reaper are more work which is done by short time and reaped with few people. Not only men but also women can operate comfortably (Aung, *et al.*, 2014). The details technical specifications of self-propelled vertical conveyor reaper used are shown in table 3.

RESULTS AND DISCUSSION

The experiment was conducted at Krishi Vigyan Kendra, Uttar Bastar Kanker during *kharif* 2014 and kharif 2015. The field observations were noted from plots for each treatment and tabulated separately.

Economics of farmer's practice

In manual broadcasting method required 2 man-days to cover one hectare area. The cost of broadcasting was INR 324 ha^{-1} (table 4). Weeding of rice consumed about 14 man days ha^{-1} with average cost of INR 2349 ha^{-1}. Whereas harvesting of crop requited 18 man days with average cost INR 2794 ha^{-1}. All the operations *i.e.* broadcasting in puddled field, weeding and harvesting were drudgery oriented, consume lot of time, labour and cost.

Table 4 : Detail average operation wise cost of rice cultivation

Particulars	Units
Labour hour required ha hrs^{-1}	10
Cost of broad casting, INR	324
Labour hour required ha^{-1} for weeding, hrs	116
Cost of weeding, INR	2349
Labour hour required ha^{-1} for harvesting, hrs	138
Cost of harvesting, INR	2794

Table 5 : Performance of paddy drum seeder in puddled fields

Particulars	Units
Seed rate, kg ha^{-1}	42.18
Hill to hill spacing, mm	68.12
Number of seeds $hill^{-1}$	3
Row to row spacing, mm	199.2
Field capacity, ha hr^{-1}	0.16
Speed of operation, km hr^{-1}	1.12
Cost of sowing, INR	324

***Average labour rate per day –INR 162*

Drum seeder vs broadcasting method of sowing

Drum seeder was tested in fields and the average speed of operation found 1.12 km hr^{-1} in sandy loam soil. The effective field capacity of paddy drum seeder

with seeding rates of 42.18 kg ha^{-1} was 0.16 ha hr^{-1} (table 5). However, field capacity of hand broadcasting was 0.20 ha hr^{-1}. The average plant population, after 35 days in the drum seeder was 328 and 308 Nos m^{-1} respectively. In the drum seeder plot, the distance between rows was 199.2 mm, however the distance between hill to hill along the rows varied with the seeding rate. On an average the hill to hill distances were found 68.12 mm in drum seeder. In conventional hand broadcasting, the seeds were scattered at random making no specific rows, so that, the operation of rotary type weeder is not possible for weed control. The study revealed use of drum seeder helped in timely sowing of crop resulting in more yield, saves costly seeds (requires 42.18 kg seeds ha^{-1}), and line sowing by drum seeder reduces weeding cost.

Table 6:Performance of ambika paddy weeder in rice

Parameters	Units
Working width, mm	149
Field capacity, ha hr^{-1}	0.016
Time requirement, hr	62.5
Weeding index, %	82.65
Cost of operation*, INR ha^{-1}	1296

***Average labour rate per day –INR 162*

Mechanical weeder Vs Hand weeding

The results obtained from the experiments, that average area covered was observed to be 0.016 ha hr^{-1}. The time required for intercultural operation of one hectare area was recorded as 62.5 hr (table 6). The weeding index was calculated as 82.65 per cent by weed count method (Number of weeds in 1 m^2 area before and after weeding was count to be 98 and 17 respectively). The minimum cost of operation was observed with Ambika paddy weeder was Rs 1296 ha^{-1} as compared to hand weeding of Rs 2349 ha^{-1} involved saving 14 human labours. Ambika paddy weeder was found more economical for the farmers as it reduced time as well as the cost of weeding operation compared to conventional hand weeding method.

Table 7: Self-propelled vertical conveyer reaper performance in rice harvesting

Parameter	Units
Fuel consumption#, *l*.ha^{-1}	6.28
Havering speed, km.hr^{-1}	2.31
Field capacity, ha.hr^{-1}	0.273
Field efficiency, (%)	67.12
Cost of harvesting*, INR.ha^{-1}	1174

***Average labour rate per day –INR 162, #- Fuel rate litre^{-1} - INR 70*

Harvesting with self-propelled vertical conveyer reaper

A self-propelled vertical conveyer reaper has 1200 mm working width. The average working speed of machine was 2.31 km hr^{-1} with 67.11 per cent field efficiency. It took 3.66 hour to harvest one hectare area and the average fuel consumption was 6.28 lit ha^{-1} (Table 7). From the study, it can be concluded that the vertical conveyor power reaper could be used successfully with a labour saving of about 15 man days per hectare and eliminating the drudgery on the part of labourers. The cost of mechanical harvesting was Rs.1174 ha^{-1} as compared to Rs. 2794 ha^{-1} in the case of manual harvesting. As the usage of machine in terms of number of hectares per year decreases, the cost of operation per hectare increases. From the above study, it can be concluded that the vertical conveyor reaper could be used successfully with labour saving of about 15 man-days per hectare and eliminating the drudgery on the part of the labour.

Table 8 : Observation of paddy crop with different methods of sowing

Treatments	Number of effective tillers, No m^{-2}	Plant height (cm)	Average hill spacing, (cm)	Panicle length (cm)	Grain yield, kg ha^{-1}
Line sowing with drum seeder	328	103	6.81	23.67	41.68
Farmers practice	308	102	3.59	23.13	35.20

Plant parameters and yield

The plant parameter observations and grain yield obtained in experiment has been presented in table 8. The plots sown with drum seeder has found grain yield 41.68 kg ha^{-1} in whereas yield in farmers practice, it was 35.20 kg ha^{-1}. The reason for higher yield in case of treatments line sowing with drum seeder may be due to optimum plant population, less weeds, higher number of tillers, and panicle length as compared to farmers practice broadcasted manually.

The study resulted in reducing arduous work load of the work regardless of the fact that who is performing the activity whether male or female worker. The study has proved its value as a new and affordable technology for the farmers. Use of drum seeder helps in timely sowing of crop resulting in more yields, saves costly seeds (57.18 %), reduces labour requirement. Line sowing by drum seeder reduces weeding cost to due to use of mechanical weeders (Ambika weeder) up to 44.82 per cent and the harvesting cost can be reduced to 57.98 per cent compared to manual harvesting respectively.

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