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Small Farm Mechanization

Technologies and Transfer Strategies

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INDIA has 2.4% of the world's geographical area and 4% of water resources, but has to support 17 and 15% of the world's human and 15% of the livestock population. Agriculture contributes 14% to the nation's GDP. Productivity in agriculture depends greatly on availability and judicious use of farm power sources and use of improved agricultural implements and machines. Agricultural machines increase productivity of labour by meeting timeliness of farm operations and enables efficient utilization of inputs such as seeds and fertilizers. During 1960-61, major contribution in farm power was from animate power (92.30%), whereas in 2009-10 major share 86.85% was from mechanical and electrical power, during which mean farm power availability has increased at a CAGR of 4.58% from 0.20 kW/ha to 1.73 kW/ha. However, the contribution from draft animal and agriculture labour source had gone down drastically in this period. Thus, there is a need for mechanization of farm, particularly small and marginal farms in dryland areas for enhancing efficiency of resources.

But many farmers still feel the implements are costly to procure on their own.Therefore, the government policies support for easy procurement process of agriculture machinery under subsidy scheme, better spare parts and service availability in rural areas and farmers centered approach in establishing and running custom hiring centers are some of the issues that need to be addressed to promote small farm mechanization at faster phase.

Effective utilization of available farm power to enhance farm mechanization activities in a country requires minimum scale or size of farms. At present in India, small and marginal farmers comprise about 84% of cultivators and their inadequate financial strength excludes them from the fold of farm mechanization. As a consequence, in the last decade (2001–2010) farm power growth rate recorded 2.0% of CAGR, which is less than half of the long term mean growth rate. To deal with a huge chunk of such small land holders and to increase farm mechanization in the country, a cautious approach is essential in selection of appropriate implements and machinery technologies needed and transfer of technologies at low cost. In this paper some such technologies useful to small farms and its transfer issues are briefly described.

Improved Implements and Agricultural Machinery Useful for Small Farms

Sowing implements

Timely seeding is essential in general and rainfed farming in particular. Delayed sowing in the window period prolongs crop growth beyond the season causing moisture stress in critical stages. With the conventional sowing practices, farmers are unable to implement required crop production practices at low cost in different growth stages because these are slow in operation and with high labour input. Mostly unskilled farm hands drop the seed and fertilizer leading to low and non-uniform crop stand in the fields. This creates imbalance in utilization of moisture and plant nutrients, which ultimately results in reduction of crop productivity.

Drill plough and plough planters: These are inexpensive and efficient single row seed cum fertilizer placement devices developed at CRIDA for attachment to country plough. Drill plough and plough planter are similar in construction, except that, in plough planter an

The farm power availability and utilization in the country is far lower than other developing countries in the world. The reasons for this situation are high cost of machines, small size farm holdings and major portion of these farmers existing in rainfed areas with poor resources base. There exists lot of scope to improve small farm mechanization activities by careful selection of existing appropriate implements, machinery and better demonstration. CRIDA, Hyderabad has developed cost effective implements suitable for small and marginal farms of rainfed areas.

Plough planter

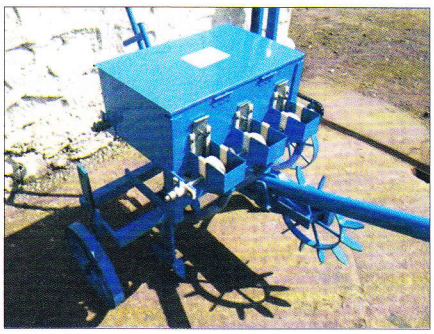
Animal drawn two row planter

inclined plate mechanism picks up and drops the seed to obtain plant spacing. The drill plough is suitable for small grain crops, in which plant spacing within the row is not much important, inputs are dropped by rubber agitator and orifice mechanism. A floating blade attached to the units covers the seed to obtain good seed and soil contact. These implements require one third of human labour and half of the bullock power, when compared to traditional seeding technique. The field capacity of both the implements ranges from 0.8 to 1.0 ha/day.

Animal drawn planters: These are automatic seed and fertilizer placing implements suitable for various rainfed crops sown at defined row spacings. These implements basically consist of a standard rectangular frame with support wheels for easy transport, turning and depth adjustment while in operation. A combined box with separate compartments for seed and fertilizer is mounted on the frame and a floating wheel is attached to provide drive for seed and fertilizer metering mechanisms. In majority of dryland zones implements fitted with replaceable inclined plate rotor and rubber agitator or plastic roller cell feed mechanism to drop seed and fertilizer respectively are highly suitable. However, models fitted with cup feed, roller cell feed mechanisms for seed and fluted roller for fertilizer mechanism are also available to suit to crop specific recommendations. These animal drawn models are available in two-row, three-row and four-row configurations to match with small to heavy draft animal pairs and as well as to cater the needs of small to medium farmers. The field capacity of these implements ranges 1.5 to 3.5 ha/ day and cost of operation ₹ 1,500 to 700/ha depending on crop row spacing.

Tractor drawn planters: There are many farmers in rainfed regions, who own tractors. In absence of matching implements, these power sources are underutilized. So, keeping this consideration in view 6, 9 and 11 row planters are developed, which cover larger areas in short period. In most of these designs, seed and fertilizer boxes are enlarged when compared with animal drawn ones to accommodate more inputs and match with either rigid or spring tyne tiller frames of tractor. At the same time precautions are exercised to avoid hindrances in setting off furrow openers for 30, 45, 60 and 90cm row spaced crops with a compromise on number of rows simultaneously can be sown. The seed and fertilizer dropping mechanisms specified in the animal drawn equipment holds good here also, with more or less same dimensions. A chain or wooden plank or iron blade is hinged at the back to cover the furrows after seed and fertilizer placement as for the field conditions. The equipment developed with such adjustments will facilitate seeding of different sole and inter crops, which ultimately increases use of machine in a given year, recovering cost incurred over the machine within a short period. The field capacity of machines ranges from 6–8 ha/day, hence could be used for custom operational service also by tractor owned farmers.

Planter cum Herbicide applicator: Planter cum herbicide applicator was developed to meet the timeliness, where in apart from sowing operation, the pre-emergence herbicide also can be sprayed simultaneously to control the weeds. The machine mainly consists of rigid frame attached with spring loaded swinging type tynes with slit type furrow openers. Individual seed cum fertilizer box attached on the top of each furrow opener facilitates for easy row space settings for different crops and precise depth control. The seed is dropped with the help of a well controlled inclined plate seed metering mechanism and the fertilizer with a spring auger. A 150W capacity pump powered by tractor battery through an inverter pump require quantity of spray fluid stored in a tank. The nozzles mounted on a boom behind the planter sprays the adjusted dose of herbicide throughout the sowing width. The field coverage of this machine is 0.4 ha/hour and cost of operation is about ₹ 1,250/ha.



Three row bullock drawn planter

Tractor drawn nine row planter

Weeding and Intercultural Equipment

Weeding is considered as most critical operation in agriculture, as the weeds compete for soil moisture and nutrients alongside crop limiting the availability. In rainfed areas, limited moisture availability during the season reduces the number of weeding days. If weeds are not removed or destroyed in time, it adversely affects the crop yields. To overcome this, CRIDA and other research institutes developed different models of improved manual operated, bullock and tractor drawn

Precision planter cum herbicide applicator

Manual push pull weeder

Tractor drawn weeder

weeders to match with various power sources and cropping pattern requirements.

Manual weeders: A model of manual weeder consists of a 30cm diameter spokes wheel with double ring made of either 16mm diameter rod or 24×3mm size mild steel flat. Two bent metal pipes of 18mm diameter on one end are fitted to the wheel bushing using a small shaft on either and on the top side, 50cm length of similar pipe or wooden handle is provided to function as a frame of the implement. Behind and close to the wheel, vertically adjustable shank with straight or crescent shape weeding blade is fitted. The other model of manual weeder has 60cm diameter wheel made of mild steel flat and metal pipe one end fitted to wheel and other ends bent to crescent shape to function as handle with a few inches height adjustment provision. A combination of finger and straight blade set is attached at rear of wheel to remove weeds. At least six to seven models of manual weeders with more or less similar in configuration are very popular across rainfed zones of India. These are simple, low cost and easily fabricated by local artisans. The field capacity ranges from 0.14 to 0.16 ha/day with 30 to 65% saving in labour.

Bullock Drawn Weeder: It consists of a rectangular metal frame to which a shank with narrow reversible or duck foot shovel at the front center of the frame and a straight blade adjusting to crop row spacing is fitted to rear beam A pipe beam attached to the frame facilitates to hitch to a pair of bullocks. The blades of different shapes, straight or V – shaped can be attached depending upon the field condition and weed intensity. Since all components are made of metal, it is long lasting with negligible maintenance. Location specific differences exist in these tools. Besides effective in removing the weeds and also in earthling up, it aids top dressing of crop rows using indigenous devices and gravity feed system attachments. The field coverage of these implements varies from 0.8-0.9 ha/day with blade widths 30 to 45 cm.

Tractor Drawn Weeder: Tractor drawn tiller frame can be used by keeping two or four tynes and removing rest to mount different sizes of straight and V- blades to use for weeding depending on crop row spacing. This type of arrangement is most suitable in the fields sown using tractor drawn seed drill or planter. The implement can cover two or four row inter spacing at a time. If the row spacing of crop is less than 40cm, we can recommend to adopt the tractor fitted with narrow width tyres (around 25 cm width), so that the plant damage can be avoided. Normally, weeding once in majority of field crops and twice in selected crops can easily be carried using existing tractor fitment without any modifications. The field coverage of tractor drawn weeder ranges from 6-7ha/day with more than 50% saving in cost of weeding. Few research and development institutes are in the process of developing tractor operated rotary weeders, which will definitely ease the weeding and intercultural operation in future.

Plant Protection Equipment

Pest and diseases management is an important component of crop production. These can have a detrimental effect on agricultural produce by affecting the quantity, quality and ultimately, the marketability of the produce. Timely application of chemicals with right type of machine leads to effective control of pest and disease, besides avoiding pollution problems.

Manually carried power sprayers: Age old hand compression knapsack sprayer models are still being widely in use in different zones. Continuous pumping of spray fluid while in operation creates pain in the forearm muscles restricting to limited area of coverage per day. Nowadays many types of power sprayer models 1 to 1.3 hp engines with 5-35 bar pressure rating; wheel barrow models 5.5 to 9.5hp power range with 10-15 bar pressure and flow adjustable nozzles are available in the market.If such machines are not used as for the guidance, lot of spray fluid goes as waste, besides under utilization of available power.

Tractor operated orchard sprayer: Conventionally farmers use pedal operated rocker hydraulic pressure sprayers to control pests and diseases in orchards. In use of such sprayers the major part of spray fluid covers outer canopy of tree foliage and spray drop does not reach to inner and the remote locations. In air carrier or air assisted sprayers, the spray droplets are further atomized, mixed with air and carried by air stream towards the target aiding in spared of entire canopy. This spray system consists of a frame fitted with spray fluid tank and power transmission from tractor PTO, pump and nozzle set, blower assembly. The air outlet ducts can be adjusted according to the tree height and an axial flow blower when pump air through ducts mixes with droplets

Tractor operated orchard sprayer

increasing its kinetic energy and covering uniformly inside and outer portion of canopy. The sprayer operates at a tractor speed of 2.4 km/hr and covers 12-14 ha/day.

Small Scale Threshing Machines

Castor Sheller: Castor is very hardy and drought resistant cash crop predominantly grown in Andhra Pradesh, Telangana and Gujarat states. Extraction of seed from castor pod is one of the important operations, which requires large number of human labour. In conventional method, one person can give an output of only about 20 kg/hr. CRIDA had developed a power-operated castor-shelling machine to save labour costs. The machine consists of a threshing drum, concave, feeding tray, a set of sieves and blower unit all are fitted over a rectangular frame. The machine is run by a 3 hp, 3- phase electric motor. Castor pods are fed manually through a feeder tray, which are crushed between threshing drum and concave and followed by shells separation by an air jet and cleaning of grain by an oscillatory sieve set. The castor sheller gives 97% shelling efficiency and 95% cleaning efficiency with an output of 700 kg/hr.

Groundnut stripper: Groundnut is a major oil seed crop in India, in which pods are stripped manually from fresh halums or after sun drying for 4-5 days, which works out to be 18-20% of total production cost. Deficit of human labour during peak harvesting season is one of the major constraints in recent past, which is leading to shifting of groundnut area to other crops. The 1 hp motor powered hold on type of ground stripping machine works on principles of impact and shearing action by a series of angular loops fixed on a rotating drum. The stripped pods fall on to the sieve and separated from leafy materials and soil.

Castor capsule sheller

Existing Problems and Transfer of Technology Strategies

The issues in small farm mechanization and the strategies to overcome them are discussed below.

- The quality of farm implements and machinery manufactured to meet the small scale farmers by mostly small scale industries in the country is generally not of desired standard resulting in poor performance, longer down time and high operational cost. The quality of equipment has to be improved inter facing user feedback and the manufacturers.
- Extension functionaries need to impart correct information to farmers to make sound decisions, so that they may be able to have better control of their lives. In the country, farmers may able to assess such information at most once or twice in a year by direct participation in Kisan or Krishi melaas, that to a cluster of villages and rest is cut off. Actual information is lacking when it is needed. In this information technology era, using appropriate technological devices interfacing, all crop production operation information is to be made available. In present system, the technologies information is scattered and costly to assess. A centralized information database for the entire state, linking all information concerning agricultural mechanization that can be accessed by farmers, extension personnel, scientists, engineers, students, and policy makers would greatly contribute to the transfer of technology.
- *Institutional weaknesses of the system:* Due to so many loop links in the system, the funding or implementing agency does not have effective control over agricultural research and development, transfer of technology budgets, management and implementation. Main problem in the overall organizational structure is obscure accountability of various implementing agencies. The research community blames slow technology transfer progress or the weakness of the extension system, but much weakness lies from the lack of low cost profitable new technologies to extend to small farm holders. Even within the Department of Agriculture and Cooperation, the multi-functional, commodity-based structure and autonomy of several major commodity agencies make it extremely difficult to effectively manage and monitor performance of the sections under its purview.
- The major portions of small landholders are in rainfed regions, in which crop yields are not assured, have limited resources and are unable to readily embrace technology. Even with the availability of credit from banks and non-banks, these are seldom patronized by farmers because of the fear of debt.
- In majority of agriculture programs, mechanization is a small part in the whole bigger issue, over looked in many instances due to complexity nature

Groundnut pod stripper

of technologies, logistical problems at on-farm conditions and lack of knowledge about the technologies. The small farm holder's mechanization aspects need to be addressed as a priority subject on continuous basis, rather than a piece meal approach with earmarked financial support irrespective of plan periods.

- In India in almost all the states, the smallest agricultural machinery spare parts and service agencies are located either at district head quarters or major towns. Agricultural mechanization will not be successful, if the spare parts and servicing are not available locally for implements and machines.
- At present central and state government departments are offering subsidy up to 50% on various small implements and machinery subjected to ceiling of ₹ 50,000/- per farmer. The procurement process of implements and machinery made to be simple within a time bound period for effective mechanization of small and marginal farms.
- There are numerous agencies working in various aspects of agricultural mechanization, state agros, state departments of agriculture, horticulture and animal husbandry; ICAR research and development institutions, state agriculture universities, financial organizations, NGO's, etc which seldom come together to formulate and implement the program in holistic manner. If all these agencies chalk out a combined strategy with clear-cut roles and rules on cluster approach in convergence mode, lot of time and man power could be saved besides saturating the selected area or zone.
- Unless and until, if smallholders do not perceive the relevance of the technologies to their own situation, they will not adopt the technologies. Participatory research basically transfers the initiative and the power of decision making to farmers, who in the final analysis have significant advantages over scientists because they have detailed and practical knowledge of their own production systems. Participatory technology development involves the active participation of all stakeholders in planning, procurement and implementation of mechanization strategies, with the role of farmers taking on centre stage.
- It is generally not economically feasible for a smallholder farmer, with a typical land holding of up to 5 ha to own a tractor and matching implements and machinery. As we have seen in the past, the state governments run tractor hire schemes have not been viable and have not helped to increase farm mechanization in small holder farms. On the other hand, the concept of servicing and renting of privately owned and operated tractors and high end selected machines are successful in crops like paddy, wheat, maize, which indicates certain possibilities of mechanizing small farms by starting a private custom service models with trained village youth and backed up by financial support. This concept needs to be tried by state governments subsidizing customized agricultural operation services rather than giving subsidy on a piece of machinery. As long as the present system of agricultural machinery subsidy continues, the farmers, machinery manufacturers and extension agencies will never come on to a common platform to address small farmers issues. Promotion of 'Custom Hiring Centre' for agricultural machinery offset adverse 'economies of scale' and 'higher cost of ownership' of high value farm equipment.

SUMMARY

There are nearly 102.8 million farmers in India; out of which 92.5% fall under marginal to semi-medium category with less than 4 hectares of operational holding. So, the average farm power availability and level of mechanization is far lower in developing countries. There are wide technology transfer gaps in meeting the needs of various cropping systems and farmers have limited access to the latest technology. Further, there is a little feedback from the farmers to manufacturers in product field performance and product improvement.

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Food

While substantial environmental impacts from food occur in the production phase (agriculture, food processing), households influence these impacts through their dietary choices and habits. This consequently affects the environment through food-related energy consumption and waste generation. 1.3 billion tonnes of food is wasted every year while almost 1 billion people go undernourished and another 1 billion hungry. Overconsumption of food is detrimental to our health and the environment — 1.5 billion people globally are overweight or obese; land degradation, declining soil fertility, unsustainable water use, overfishing and marine environment degradation are all lessening the ability of the natural resource base to supply food; and the food sector accounts for around 30% of the world's total energy consumption and accounts for around 22% of total Greenhouse Gas emissions. Increased consumption adversely affects food security — increase in food prices, upsurge in production methods that use more resource-intensive food products, and resource-intensive foods deplete the agro-ecological resource base, affecting its ability to produce plentiful food.

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– See more at: http://www.unep.org/wed/theme/food.asp#sthash.InW07J4d.dpuf

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