

Small farm mechanization in rainfed based cropping system

for drudgery reduction and livelihood security

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In India, about 60% of net sown area is under rainfed agriculture and the rainfall majorly scripts the people's livelihoods. The poor fertility status of soil and lower moisture holding capacity further make the rainfed farming more complex. There is an urgent need to address small farm mechanization aspects of the farmers to meet the timeliness of operations, reduce drudgery and enhance the input use efficiency to improve the productivity from rainfed agriculture. In this study, need based improved agricultural implements and small scale machinery were introduced to farmers and its utility was assessed in a cluster approach mode in Pudur mandal, Telangana. The results showed that, interventions reduced the drudgery load. The selected set of implements saved time and cost through reducing physical work load and altering working posture. Small farm mechanization not only increased the labour productivity by reducing drudgery, but also helped in bringing more area under cultivation and enhances the farm holder's livelihoods security.

Key words: Drudgery, Farm mechanization, Improved practices, Rainfed farming

INADEQUATE and uneven distribution of rainfall, prolonged dry spells, low fertility and low moisture holding capacity of soils hinder the production process of rainfed based cropping systems. So, timeliness of operations plays a greater role in rainfed system. This can be achieved by selecting appropriate improved agricultural implements and agricultural machines increase the productivity of labour by meeting timeliness of farm operations and enable efficient utilization of soil moisture besides valuable inputs such as FYM, seeds, fertilizers and bio-agents. During 1960-61, a major contribution in farm power was from animate power (92.30%), whereas in 2013-14 major share above 88.0% was from mechanical and electrical power, during which mean farm power availability has increased at CAGR

of 4.58% from 0.2 kW/ha to 1.84 kW/ha.

Importance of small farm mechanization

About 60% of women in India are involved in various agricultural and allied activities. As a consequence, there is a growing demand for designing and development of women-friendly agricultural tools and small power operated machines in India for different operations. To name few such types of tools and machines include hand-operated dibbler, wheel hoe, maize sheller, finger guard for flower plucking, paddle operated thresher and strippers for groundnut pods separation etc. Especially the resources poor rainfed farmers are not able to acquire high capacity machines due to land fragmentation, numerous cropping systems and low acreage under a particular cropping

system. Thus, there is a need for mechanization of small sized farms, particularly to meet small and marginal farmer's requirements in rainfed regions for enhancing the efficiency of resources, drudgery reduction and safeguards livelihood security of own family labour.

In spite of many new developments in small farm mechanization spear, availability of such useful small tools and machines in rural areas is a big question mark and on the other side many farmers still feel the implements are costly to procure on their own. Therefore, the government policies support easy procurement process of agriculture machinery under subsidy scheme, better spare parts and service availability in rural areas. Farmers centered approach in establishing and running custom hiring centers on crop colonies (production catchment)

basis are some of the issues that need to be addressed to promote small farm mechanization at a faster pace. To deal with a huge chunk of such small land holders and increase farm mechanization in the country, a cautious approach is essential in selection of appropriate agricultural implements and machinery technologies and transfer of low cost technologies.

Importance of agriculture in livelihood security at rural level

The issue of rural population livelihood is complex and intimately linked with the performance of agriculture and allied sectors. Inadequate credit availability for agriculture, weather related risks and uncertain market support are forcing the farmers to leave agriculture slowly and go for alternate employment generation activities in rural areas. The agriculture performance in rural areas not only affects the farming community but also the landless labourers, small scale agro-processing industries and rural artisans alike. This effect is clearly visible in case of rainfed areas which are prone to greater risks.

Considering the importance to develop natural resource in rainfed areas, the government of India gave significant focus on land and water resources improvement and livestock production to have better chance to reduce poverty. The goal of improving rural livelihoods has now become a major research agenda in the country more so in the highly vulnerable rainfed areas. This vulnerability has to be addressed by giving new skills to the poor along with up-to-date technologies and building of durable income generating activities and capacity to adapt to rapidly changing markets. Against this background, the project on “Farmers’ centric natural resource development for socio-economic empowerment in rainfed areas of southern Telangana region” has been formulated under the Farmer FIRST Programme and selected village cluster of Pudur Mandal, Vikarabad district of Telangana. The present paper enumerates the farm power availability status in the cluster at the

entry level of this project, various small farm mechanization interventions, implemented to reduce drudgery and enhance livelihoods of farmers.

Drudgery in agricultural operations

The Pudur cluster comprises of a group of 4 small gram-panchayats in the Vikarabad district. The major occupations in the cluster are farming (90%) followed by labours working (4.5%) in a nearby industry for a major portion of time in a year and agriculture labours (5.5%). Annual mean rainfall in the cluster is 750 mm. Traditional agriculture has been the backbone of cluster primarily in terms of subsistence livelihood security and food supply. Among the farming families, small farmers are more in number followed by medium and large farmers. In the total geographical area, most of the land (82.26%) is under rainfed cultivation except few acres of CPRs under undulating terrain. Cotton is the predominant crop in the cluster followed by red gram, maize, jowar and paddy. Field crops are grown mostly in *kharif* season and to a little extent in *rabi* with one or two supplemental irrigations. However, about 18% of the farmers grow flowers and vegetables in *kharif* and *rabi* under protected irrigation.

The household social assets (Table 1) available in the cluster play a vital role in enabling rural households to address their farm-power constraints. That total power availability in the cluster is inadequate, but the availability of sources matching implements and machinery is a question (Table 1). Some households in the cluster tackle farm power shortage on an individual basis through reciprocal labour or by pooling their draught animals. Majority of households in the cluster rely on family labour for all their farming needs. Many do not have even enough essential hand tools for all household members to carry out various farming operations. They race against time from sowing of seed to the harvest. The timeliness of farm operations is often compromised by hiring their labour to others at the busiest times of the cropping season.

The most common implements used in the cluster in land preparation activity are tractor and animal drawn country plough/ cultivator. Other equipment mostly used by the farmers were hand hoes and sprayers. Nearly 50% of the land holding households has pumping sets. Whatever groundwater available with them in bore / open-well, are used for raising food and cash crops like paddy, different types of vegetables and flowers. Consequently, based on the cropping pattern prevailed in the cluster, the improved implements and machines suggested to promote small farm mechanization in the cluster are enumerated in Table 2.

Small farm mechanization visa- a-vis drudgery reduction

After all the production related constraints were identified, they made into sub tasks. Among them, only women exclusive and women equal participation tasks were selected and interventions were introduced to quantify the drudgeries (discomfort) and energy consumption as per factors described in equation 1. Six farmers representing various agricultural operations from the operational villages were selected for drudgery assessment. A data collection schedule was developed and standardized to collect the data from farmers by recall method and various limb movement position analyses. The interview schedule contained general information, where in details on subject’s ages, years of farming, family size, land holding status, crop calendar, gender participation and technology used were elicited apart from six variables (equation 1) and energy using equation 2. Each factor value was taken from the standard table after assessing quantitative and qualitative methods. Activities were considered as independent and the six factors as dependent for understanding the source of variation from various agricultural operations and factors for the purpose of study. Significance level was assessed using students t-test.

Total drudgery (equation 1) was calculated using linear combination

method.

$$D_{TL} = [FG + HA + W_O + W_C + P_S] \times Tr \quad (1)$$

Where, D_{TL} = Total drudgery load; FG – Force transfer and gripping factor; HA – Hand-arm position factor; W_O – Work organization factor; W_C – Work condition factor; P_S – Posture factor; Tr - Time rating factor;

$$E = 0.159 \times HR - BMR \quad (2)$$

Where, HR – Heart beat (beats/min), BMR – Basal metabolic rate (8.72 kJ/min)

As for the drudgery load, viz. harvesting of crops (52.5), weeding and vegetable transplanting (49) using traditional practices were categorized as having high level of drudgery whereas, in spraying (38.5) and winnowing (35) operations little lower drudgery. As per the test factors, drudgery load was found highly associated with posture and repetitive action of limbs while in operation of the subjects. The total drudgery load calculated after introduction of small farm mechanization intervention infer that, the mechanization actions drastically reduced the load on various farming operations studied in the range of 40 to 64.3%. The maximum total drudgery load reduction was observed in weeding using wheel hoe and minimum in winnowing operation with winnower fan. The other operations in which total drudgery load reduction observed were harvesting using brush cutter (60%), vegetable seedlings transplanting (57.1%) and seed treatment (53.8%) using seed treating drum. In all the activities selected, operations with traditional practices demanded more energy expenditure when compared with improved tools (Table 3). All the improved practices were significantly ($P < 0.01$) able to reduce the drudgery across all the selected practices and saved energy consumption ($P < 0.05$) when compared with traditional practices except spraying. The energy expenditure in traditional working style ranged from 9.0 to 9.88 kJ/min,

Table 1. Social assets in farming operations of the cluster

Parameter	Units, Nos	Parameter	Units, Nos
Population	2,980	Tractor drawn cultivators	20
Agricultural workers	1,987	Cage wheels - pairs	2
Area under cultivation (acres)	1,860	Tractor drawn seed drills	4
Rainfed area, %	82.26	Hand hoes	500
Draft animals, Pairs (DAP)	27	Sprayers	299
Country ploughs	5	Open well pump sets	125
Levelling plank	27	Bore well pump sets	234
Tractors	20		

Table 2. Technological gaps identified and improved implements suggested for the cluster

Operation	Implements being used	Crops	Improved Implements suggested
Field preparation	Tractor drawn cultivator, country plough, leveling plank	All crops	Bullock drawn 2, 3 Tyne cultivators cum blade harrow
Seed treatment	Gunny bag / manually mixing	Red gram, maize, chickpea	Seed treatment drum
Sowing/Seeding	Dibbling, broadcasting, seed dropping behind country plough, tractor drawn seed drill	Cotton, maize, red gram, sorghum, chickpea	Pora tube attachment to country plough, Two tyne gorru with pora tubes, Two row mechanical planter
Vegetable seedlings transplanting	Manual	Tomato, brinjal, green chilly, cabbage, <i>chrysanthemum</i> , marigold	Hand operated easy seedling transplanter
Weeding and Intercultural operations	Spade, hand hoe and Sickle, animal drawn blade harrow	All types of field crops, cotton, vegetables and flower crops	Wheel hoe, power weeder, animal drawn blade harrow
Plant protection operation	Lever operated knapsack sprayer	Cotton, red gram, chickpea, vegetables and Flower crops	Battery operated sprayer, power sprayer
Harvesting	Sickle	Paddy, sorghum, maize, red gram, fodder crops	Serrated sickle, brush cutter
Threshing	Manually beating	Paddy, sorghum, maize, red gram	Threshing drum, power operated small sheller, Winnower fan
Winnowing	Dropping grain and chaff in blowing wind	Paddy, sorghum, maize, red gram, chick pea	

when compared with 7.81 to 9.26 kJ/min of improved tools and practices. As for the work classification based on the energy consumption pattern, all operations in this study fall in the category of moderate physical work load.

Small farm mechanization and livelihood security

The livelihood outcomes for households owning draught animals or appropriate small power operated implements and machines for various crop production operations in arable cropping systems are more food secure than those relying on sole on

family labour, traditional tools and practices. The observations taken at various farm holders in the cluster suggested that, while traditional practices households without any major power source typically cultivate up to 1.5 acre per year, draught-animal or small power operated implements and machines owning households able to cultivate up to 5 acres per year, and households owning tractors cultivate more than 15 acres per year. The farmers having draught animals or power operated machines follow more diversified cropping patterns and there is greater emphasis on cash crops production



Fig. Weeding operation by farmer with wheel hoe and self-propelled weeder

like cotton, red gram and more area under vegetables.

Households hiring farm power do not enjoy the same level of security as owners of farm power. They have less certainty as draught animal pair (DAP) and tractor owners meet their own needs first, and the hire services may be monopolized by more influential farmers and close relatives. The areas cultivated tend to be smaller than that of owners; DAP hirers typically cultivate 2 acres and tractor hirers up to 5 acres in the cluster.

As the farm operations wages and working pattern is concerned, it is needless to say that man was getting higher wages than woman in all categories of farming. The observations showed that, men and women were working equal amount of time in all the categories of farming. In case of number of hours spent per day, women were spending more time in farm activities than the family activities in all the categories. Women work 9 hours a day in both activities together with traditional tools and methods, which possibly result in physical fatigue and drudgery in various operations.

There is no doubt that farm implements and machinery technologies other than a country

plough and hand hoe offer considerable advantages in terms of area cultivated, labour saving, total yields achieved, levels of drudgery reduction, opportunities to redeploy family labour, and household food security. After careful study of cropping pattern in the cluster and various hand tools, farm operations implements available with the farmers and agriculture workers, to improve household livelihoods; farm implements and machinery technological intervention package action plan as listed in Table 2 was drawn up. The small tools are made available to the farmers on custom hiring basis at a nominal rental fee for landholding households and on free for landless and agricultural workers.

Along with provision of farm implements, skill development and gender awareness training for men and women have been key parts of the FFP programme. The improved small tools and machines saved the labour to an extent of 29 to 85% and cost to the tune of 20 to 45% (Table 4). The maximum labour saving (85%) was observed in case of bullock drawn blade harrow in intercultural and weed control operation with cost saving of 45%.

The implements tested in the programme have met with varying degrees of acceptance among the farmers. For example, women took the seed and fertilizer application with pora tube, weeding with wheel hoe, vegetables transplanting with

Table 3. Drudgery load and Energy expenditure in selected agricultural operations

Practices	Drudgery		Energy Expenditure, kJ/ min	
	Improved practices	Traditional practices	Improved practices	Traditional practices
Seed treatment	21.0 ^A	45.5 ^B	8.38 ^a	9.40 ^b
Vegetable seedling transplanting	21.0 ^A	49.0 ^B	7.81 ^a	9.0 ^b
Weeding	17.5 ^A	49.0 ^B	9.26 ^a	9.88 ^b
Spraying	21.0 ^A	38.5 ^B	9.09	9.25
Harvesting	21.0 ^A	52.5 ^B	8.83 ^a	9.48 ^b
Threshing	17.5 ^A	45.5 ^B	8.83 ^a	9.46 ^b
Winnowing	21.0 ^A	35.0 ^B	8.62 ^a	9.26 ^b

A,B, a and b different super-scripts in sub-columns differ significantly at 5% and 1%, respectively

Table 4. Advantages of various farm Implements when compared with traditional practices/ tools

Implement saving (%)	Farm operation	Capacity	Labour saving (%)	Cost
Bullock drawn blade harrow	Land preparation	0.75 ac/d	30	25
2-Tyne cultivator with pora tube	Sowing	1.5 ac/d	50	33
2-Row mechanical planter	Sowing	1.2 ac/d	65	45
2, 3-Tine cultivator / Blade harrow	Field preparation, Intercultural and weeding	0.65-0.90 ac/d; 1.5 ac/d	4085	3045
Easy hand seedlings transplanter	Seedling trans-planting	150 m ² /hr	30	25
Manual weeder	Weeding	210 m ² /hr	29	25
Power weeder	Weeding	273 m ² /hr	34	29
Small power maize sheller	Grain separation from cobs	40 kg/hr	30	20

easy planter; whereas other technologies, such as 2/3 tyne cultivator, blade harrow, battery sprayer, power weeder and beating drums for paddy threshing proved more popular among man farmers. The programme has created a demand for these tools within the community. Benefits of adoption include reduced drudgery and time saving for women, development of skilled and more productive labour. These tools helped to empower women. There is also demand within the community for more sophisticated and expensive implements and machinery.

With the availability of more wheel hoes (Fig. 1) instead of hand hoes, specially woman was slightly relieved from weeding tasks that traditionally were a woman's task. More time availability offers real opportunities for diversification options such as increasing area under cash crops and vegetables, taking vegetables to nearby city mandies for sale. The main impact of improved tools like 2/3 tyne cultivators and blade harrow, which are developed for primary, secondary tillage operations is to increase the area under cultivation. In turn, this created a demand for additional

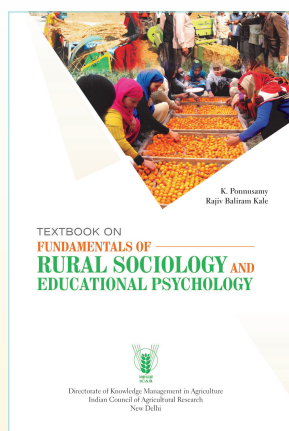
labour for subsequent operations.

Conclusion

This study has endeavored to identify the factors which hindered the agricultural productivity and introduced a selective set of more appropriate tools and small-scale machines for rainfed agricultural mechanization. Significant changes in physical load drudgery reduction were observed, while working with these tools and machines as compared to traditional tools and practices. The improved technological interventions in seeding, transplanting seedlings and weeding saved labour thus contributing to cost saving. The observations indicated that by meeting of timeliness of operations using these technologies, more area could be brought under cash crops or daily income earning cropping practices which simultaneously meets the small farm mechanizations and farmers livelihood and nutritional security.

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TECHNICAL SPECIFICATIONS

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