INSTITUTION OF AGRICULTURAL TECHNOLOGISTS,

BENGALURU

EVALUATION OF RKVY PROJECTS

OF

UNIVERSITY OF AGRICULTURAL SCIENCES,

RAICHUR

"DESIGN AND DEVELOPMENT OF LOW COST AGRICULTURAL TOOLS AND EQUIPMENT FOR MECHANIZATION OF SMALL AND MARGINAL FARMS"

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CONTENTS

"DESIGN AND DEVELOPMENT OF LOW COST AGRICULTURAL TOOLS AND EQUIPMENT FOR MECHANIZATION OF SMALL AND MARGINAL FARMS"

EXECUTIVE SUMMARY

Agriculture, as a significant contributor to employment and livelihood creation, continues to be the mainstay of India's rural economy. Over 60 per cent of the Indian population continue to depend on agriculture and allied activities for their livelihood. Hence, growth of this sector is an essential prerequisite for overall economic growth.

The mechanization of agriculture that took place during the 20th century led to major changes in how farmers plant, irrigate and harvest crops. Agricultural mechanization is the process whereby equipment, machineries and implements are utilized to boost agricultural and food production. It is the application of machineries, equipment and implements in the day to day farm activities to increase marginal output in food production and poverty eradication. Agricultural mechanization reduces drudgery which hitherto makes it difficult for large scale food production and which has also been making it difficult for nations who have to meet their food requirements for the teeming population. In order to solve the problem of drudgery and other problems associated with food production, various measures have been introduced to combat these problems through mechanization. Agricultural mechanization involves the design, manufacture, distribution, use and servicing of all types of agricultural tools, equipment and machines. The efficiency of mechanization can be judged from the fact that modern plough is about 200 to 300 % efficient than indigenous plough, efficient machinery helps in increasing productivity by about 30% besides enabling the farmers to raise a second crop or multi crop making the Indian agriculture attractive and a way of life by becoming commercial instead of subsistence (Arun Khurana, 2020).

Innovation in farm machinery sector will drive the next phase of agricultural growth in the country, with focus on spreading farm mechanization to small and marginal farmers and regions that have low farm power availability. As a result, Indian farmer is fast adapting farm mechanization than ever before. The agriculture equipment market in India is presently valued at 6.5 billion USD and has enormous potential for further growth. The tractor market is expected to grow at a CAGR of 8-9 % in next five years. The joint efforts made by Government and farm equipment industry in the country have led to such progress in mechanization over the years (Arun Khurana, 2020). Research and development efforts and approaches in agricultural mechanization in India have been directed towards finding cost-effective solutions to location-specific problems of agriculture.

It is against this background, the present project of **"DESIGN AND DEVELOPMENT OF LOW COST AGRICULTURAL TOOLS AND EQUIPMENT FOR MECHANIZATION OF SMALL AND MARGINAL FARMS"** has been taken up by University of Agricultural Sciences, Raichur at their College of Agricultural Engineering, Department of Farm Machinery and Power Engineering, Raichur. The project was implemented from 2010 to 2014. The details of the project are as under:

1.	**Title of Project**	**:**	**"DESIGN AND DEVELOPMENT OF LOW COST AGRICULTURAL TOOLS AND EQUIPMENT FOR MECHANIZATION OF SMALL AND MARGINAL FARMS"**
2.	**Nodal officer**	**:**	**Er. Ravindra S. Yaranal** Asst. prof (Sr. grade), (Department of Farm Machinery and Power Engineering) College of Agricultural Engineering, Raichur
	Principal Investigator (PI)		**Er. Ravindra S. Yaranal**
	Co- investigators		**1. Er. Sushilendra** **2. Dr. M. Anantachar** **3. Dr. K.V. Prakash** **4. Dr. M. Veerangouda** **5. Dr. Vijayakumar Palled**
3.	**Implementing Institution (S) and other collaborating Institution (s)**	**:**	Department of Farm Machinery and Power Engineering, College of Agricultural Engineering, Raichur
4.	**Date of commencement of Project**	**:**	2010
5.	**Approved date of completion**	**:**	2014
6.	**Actual date of completion**	**:**	2014
7.	**Project cost**	**:**	Rs. 50 lakhs

The objectives of the project were as under:

- To identify, design, development and performance evaluation of agricultural tools and equipment required for the mechanization of small and marginal farm
- To conduct large scale demonstrations of developed agricultural tools and equipment in farmers' fields of selected villages for their promotion

- To conduct training programmes on cost effective production technology of agricultural tools and equipment for small scale manufacturers, farmers and village artisans

The focus of Evaluation is:

i. Review of data on design and development of new equipment for various crops and modifications of existing equipment
ii. Review of data on procurement and custom hiring of farm machinery and economic feasibilities of identified agricultural equipment/ machinery.
iii. To get feedback from farmers on usefulness and techno-economic feasibilities of various equipment.
iv. Study level of knowledge transfer to farmers.

The intention of the scheme was to design and develop crop specific, cost effective, easy to operate and efficient and innovative farm equipment and machinery to enable farmers to take up intensive farming and provide expertise to manage higher productivity and profitability per unit area transfer this technology to the farmers through large scale demonstrations and trainings.

The underlying logic is;

a. The farm machinery will help farmer in bringing in timeliness and precision to agricultural operations, greater field coverage over a short period
b. Cost effectiveness, efficiency in use of resources and applied inputs bringing precision in metering and placement of inputs, reducing available input losses, increasing efficiency of costly inputs
c. Reducing cost of production by quicker and efficient operations and minimized losses in production, processing and preparing the produce for market.

The following tools and equipment were developed in the project:

- Pedal operated maize sheller
- Hand operated single acting maize sheller
- Hand operated double acting maize sheller
- Push/pull type weeder cum collector
- Hand operated push type sprayer
- Manual operated multicrop thresher
- Manual operated double row planter
- Hand operated dibbler
- Standing khurpi type weeder

The efforts made by University of Agricultural Sciences, Raichur in identifying, design and development of small equipment suitable for small and marginal framers are noteworthy and appreciable. However, the information relating to large scale demonstrations and trainings involving farmers, small manufacturers and village artisans is lacking vis a vis the preset objectives.

However, there is need to critically examine the efficiency of equipment being used presently in cultivation of the major crops in the area of operation of the University of Agricultural Sciences, Raichur including Bidar, Kalaburgi, Yadgir, Raichur, Ballari and Koppal. Suitable steps may be taken to develop/ modify the equipment to reduce the drudgery of work, improve efficiency leading to improvement on production and productivity.

No scientific and systematic evaluation on the efficiency and economic feasibility of the machineries developed/ modified by UAS, Raichur has been made. This would have thrown light on the usefulness of the new machineries developed/ modified. In the absence of this information, acceptance of the machineries by farmers and their popularization will be difficult.

While the pedal operated and to some extent manual single and double cob maize shellers are better that the traditional methods of shelling, their usefulness appears to be doubtful as they do not do away with human drudgery. The farmers are more inclined to hire power driven maize shellers which are more efficient and more time saving. Use of power driven maize shellers has become a regular practice in most maize growing areas of the state.

The weeders developed are noteworthy and have to be popularized in the area through field demonstrations and commercial production.

The dibbler developed will be useful especially in cotton crop where manual planting of seeds has many a times resulted in low/ thin crop stands due to planting done at different depths by labourers. The equipment needs to be popularized among farmers. The sprayer developed is a useful innovation.

REFLECTIONS AND CONCLUSIONS

1. More efforts are required by UAS, Raichur to demonstrate these equipment in association with Karnataka State Department of Agriculture and Department of Horticulture and extension wing of University and identifying manufacturer to produce in large number These machines have to be added in the Custom Hire Service Centres and leased to farmers to improve their popularity and usage. More

publicity for newly developed equipment through both print and electronic media is required to make them popular and for wider usage. KSDA and Department of Horticulture should chalk out the strategy to popularize the equipment by way of including the equipment through existing various subsidy schemes (particularly in all district mechanization programmes to be supported by ZP).

2. The comparative cost efficiency of all equipment vis a vis the traditional equipment and manual labour have not been carried out systematically and scientifically. This would have thrown light on economic advantages of using the newly developed equipment.
3. There is need for creating and documenting scientific data base on equipment efficiency in terms of function, brief description, capacity, benefits, costs, source of availability, name of the manufacturer etc. Information on the following technical aspects may also be documented:
   i. Fuel efficiency / time efficiency
   ii. Reducing drudgery.
   iii. Duration of operation i.e., area covered, equipment overall efficiency, soil condition etc.
   iv. Cost of cultivation compared to conventional methods i.e. economics of operations and savings needs to be worked out.
4. UAS, Raichur should attempt to apply and obtain patent for the new machinery and commercialize the equipment through tie up with farm machinery manufacturers for mass production of the machinery. There is need for creation of brand name for equipment developed.
5. There is need to design regular training programmes to educate the farmers on upkeep, maintenance and repairs of the farm machinery developed.
6. There is need of Human resource developed in terms of use of machinery in Agriculture. The Agri Diploma graduates may be trained in maintenance of Farm power and machinery for skill development on EARN WHILE YOU LEARN mode.
7. At present, the machinery developed under the project may be compared with the power (1-3.5 KW) operated machinery commercially available and already under Government programmes and they may be introduced in custom hiring center under Krishi Yantra Dhare scheme to mechanize farm operations suitable for small and marginal farmers.
8. A core team of experts at the Institution level to identify the developed equipment as a women friendly equipment and policy support from University to popularize among farmers.
9. To support women friendly equipment, University may post one of the subject matter specialists and an Agricultural Engineering expert in all KVKs and popularize this equipment through FLD/Training to propel small and marginal farmers towards adoption of these equipment to reduce drudgery in farm operations.

ACTION POINTS

1. While commendable efforts have been made to develop cost effective low cost equipment to carry out various farm operations, the performance evaluation of the equipment could have thrown better light on efficiency of the equipment.
2. The project is silent on the information on adoption of the equipment developed under the project by farmers. There is need to evaluate the performance of the equipment in farmers' fields and take up commercial production for use by farmers.
3. Although the equipment developed are said to reduce the drudgery of agricultural operations, efforts are needed to popularize their use through demonstrations in farmers' fields for which convergence of line departments is needed.
4. There is need to list the major farm operations in the major crops of the area and examine the efficiency of the equipment being presently used in these crops for different farm operations and need for development of new equipment. Present study has mostly concentrated on maize and cotton crops although in the area of operation of the University many other important crops like pigeon pea, soybean, green gram, black gram, paddy and Bengal gram are grown commercially. There is need to review the usefulness of the equipment presently being used in these crops.
5. There is need for working out drudgery reduction and cost of covering the cultivable one acre of land (i.e., Benefit Cost Ratio to be worked out).
6. The viability and impact of small low cost agricultural tools and equipment by small farmers is not viable for which the project should continue on PPP mode.
7. There is need to work out the durability/ longevity of the equipment besides economics.
8. Manpower requirement/ training is needed in order to improve the use and efficiency of equipment leading to reduction in cost of production and enhancing the profitability of farmers.
9. KSDA and Department of Horticulture should chalk out strategies to popularize the equipment by way of including the equipment in various existing subsidy schemes (particularly in all district mechanization programmes to be supported by ZP).
10. There is need for developing simple machinery with multiple use at farmer's field with cost effective attachments.
11. Light weight and strong materials non-corrosive in nature should be used in designing and developing new equipment for which collaboration with Defence Research and Development Organization (DRDO), Hyderabad may be sought.
12. The impact of conducting training programmes and the feedback from trainees needs to be documents.
13. The project has not documented the role of local artisans. They should be trained in developing new equipment.

"DESIGN AND DEVELOPMENT OF LOW COST AGRICULTURAL TOOLS AND EQUIPMENT FOR MECHANIZATION OF SMALL AND MARGINAL FARMS"

INTRODUCTION

Agriculture, as a significant contributor to employment and livelihood creation, continues to be the mainstay of India's rural economy. The sector remains crucial for the economy, in order to create a ripple effect on the services and manufacturing sectors of the economy, to meet food and nutritional requirements of our population and to contribute to macroeconomic stability.

Over 60 per cent of the Indian population continue to depend on agriculture and allied activities for their livelihood. Hence, growth of this sector is an essential prerequisite for overall economic growth. The technological improvements in Indian agriculture since mid-sixties have brought about revolutionary increase in agricultural production. Globally, India is the third largest producer of cereals, with only China and the USA ahead of it. India is 2nd in rice, wheat and production of other cereals. India is 2nd largest global producer of fruits and vegetables with 254 MT production. India is 1st in milk production with 155.5 MT production in 2015-16 (FICCI, 2017). India is the second largest producer of fish and second largest producer of inland fisheries in the world. India ranks first in respect of cattle and buffalos and second in goats, third in sheep and seventh in poultry population in the world. India is also 3rd in egg and 5th in meat production.

India has now become not only self-sufficient but also a net exporter of food grains. This has been made possible due to evolution of high yielding crop varieties, increased use of chemical fertilizers, development of irrigation facilities and plant protection measures accompanied by effective price support programmes of farm products.

Food and nutrition security are intimately interconnected, since only a food-based approach can help in overcoming malnutrition in an economically and socially sustainable manner. Food production provides the base for food security as it is a key determinant of food availability. The Indian food industry is poised for huge growth, increasing its contribution to world food trade every year. The country achieved a production level of 284 million tonnes in 2016-17.

Karnataka, the fourth largest state in the country in terms of geographical area, is one of the leading states in the development of agriculture and allied sectors. Karnataka's economy is an agrarian economy and the overall development of the State is mainly depending on the growth and development of agriculture and allied sectors. Karnataka

State is endowed with rich and diversified agro-climatic zones with abundance of natural resources and produces a wide range of food products including cereals, pulses, oilseeds, tropical and sub-tropical fruits and vegetables, spices, aromatic and medicinal plants, animal products like milk, mutton, pork, eggs and fish and other food products like sugar and wine. There has been significant increase in productivity and quality in the food production in the State over the last decade. The Government of Karnataka considers high growth of agriculture and allied sectors as a means to accelerate the State's GDP growth, enable farmers to earn higher income and ensure food security. With the rich biodiversity and 10 diverse agro climatic zones of the state conducive to the cultivation of various kinds of food and horticultural crops including aromatic and medicinal plants, large dryland farming area with intensive and vast watershed development programmes for improving dryland productivity leading to significant production of coarse cereals, millets, pulses and oilseeds and focus on shifting the production strategies from subsistent to intensive commercial farming, the state has emerged as a leading state with nutritionally balanced food production. Karnataka is the largest producer of maize, sorghum, coffee, sunflower, finger millet, cucumber, capsicum, chilli, sapota, grapes, pomegranate, pepper, onion, tomato, watermelon and one of the top producers of mutton, pork, eggs and milk (Karnataka Agriculture Policy guidelines, 2019).

The technological improvements in Indian agriculture since mid-sixties have brought about revolutionary changes in agricultural production. The country was facing acute food shortages till eighties has now become not only self-sufficient but also a net exporter of food grains. This has been made possible due to evolution of high yielding crop varieties, increased use of chemical fertilizers, development of irrigation facilities and plant protection measures accompanied by effective price support programmes of farm products.

The increased use of purchased and costly inputs in agriculture and possible effects on environment has necessitated to raise their use efficiencies. The timeliness of operations has assumed greater significance in obtaining optimal yields by ensuring the efficiency in use of the costly inputs. However, increase in the use of human and bullock labour and rising wage rates and cost of up-keep of bullock has led to increase in cost of production nullifying the efforts of increased production potential. While efforts are being made to exploit the production potential of various food production contributors, the focus must shift to simultaneously reduce the cost of improving the efficiency of applied inputs.

Farm mechanization has been helpful to bring about a significant improvement in agricultural productivity by improving the efficiency in use of costly inputs. For instance, the sowing of wheat in Punjab is done up to the first fortnight of November. A delay beyond this period by everyone week leads to about 1.50 quintals per acre decrease in the

yield. This is also correct in the case of other crops and for other farm operations like hoeing, irrigation, harvesting, threshing and marketing which need to be performed at appropriate time otherwise the yield and farm income is affected adversely. Secondly, the quality and precision of the operations are equally significant for realizing higher yields. The various operations such as land leveling, sowing and planting, use of fertilizers, plant protection, harvesting and threshing need a high degree of precision to increase the efficiency of the inputs and reduce the losses. For example, sowing of the required quantity of seed at proper depth and uniform application of given dose of fertilizer can only bring about improvement in yields. When such operations are performed through indigenous methods, their efficiency is reduced. Thirdly, the time taken to perform sequence of operations is a factor determining the cropping intensity. So as to ensure timeliness of various operations, it is quite inevitable to use such mechanical equipment which have higher output capacity and cut down the number of operations to be performed.

Normally, there are good chances to reduce the cost of production if farm operations are mechanized as it saves labour, both human and bullock. In the absence of mechanization, the ever-increasing wage rate of human labour and cost of upkeep of draught animals could have increased the cost of production much higher. Further, large scale production means less per unit cost on the farms. Moreover, it reduces the weather risk and risk of non-availability of labour and thus wastage is minimized. Timely marketing is also made possible by quick mechanical transportation, cleaning and handling. Further, the area under fodder and feed for draught animals could be reduced due to decline in their use. The land thus released can be brought under commercial crops. The use of farm mechanization enlarges the employment opportunities both on farms and in nonfarm sectors through increase in area under plough, multiple cropping, development of agro-industries and related services. Also, the drudgery for human labour is reduced and unhygienic operations such as handling of farmyard manure can be done with machinery.

The agriculture sector value chain includes all the steps involved from preparation of soil to harvesting and post-harvest processing. For every step in the production lifecycle, use of equipment enhances the efficiency of the unit involved. Farm mechanisation not just reduces labour time and post-harvest loss but also helps to cut down production cost in the long term.

Studies have shown a direct relationship between farm mechanisation (farm power availability) and farm yield. Farm mechanisation is said to provide a number of input savings:

- Seeds (approximately 15-20 %)
- Fertilizers (approximately 15-20 %)
- Increased cropping intensity (approximately 5-20 %)

Increase in efficiency:

Aside from the above stated inputs, farm machinery also helps in increasing the efficiency of farm labour and reducing drudgery and workloads. It is estimated that farm mechanisation can help reduce time by approximately 15-20 percent. Additionally, it helps in improving the harvest and reducing the post-harvest losses and improving the quality of cultivation. These benefits and the savings in inputs help in the reduction of production costs and allow farmers to earn more income (FICCI, 2015).

Indigenously developed agricultural hand tools and implements have also evolved over time and despite the strides agricultural machinery has made, continue to play a critical role in agriculture. This is on account of the small and irregular farm sizes, lack of machinery available for smaller land holdings, lack of awareness and skills among farmers and inability of farmers to afford more advanced technologies. Hand tools have also been developed for all levels of the value chain. In 2010, when the size of the agricultural labour force was 269.74 million, the estimated number of hand tools in use was 809.22 million, which equates to about 3 hand tools per labourer (FICCI, 2017).

However, the prevalence of these tools comes with the issue of safety. An ICAR study (2004-2007) showed that 34.2 percent of accidents in agriculture were due to hand tools, with sickles and spades involved in 46 percent of farm injuries. Implications of injuries due to hand tools are severe as these injuries are very painful and disabling due to delayed treatment. A survey conducted in India showed that 70 percent of agricultural hand tools injuries had a recovery time of more than seven days. Thus, developing farm machinery more suited to the local conditions is essential so that injuries and problems that come with the use of hand tools can be abated while making agricultural practices more productive (Shreemath shreshta,2017).

Social benefits:

There are various social benefits of farm mechanisation as well:

- Helps in conversion of uncultivable land to agricultural land through advanced tilling techniques and also in shifting land
- used for feed and fodder cultivation by draught animals towards food production.
- Decrease in workload on women and drudgery of operation as a direct consequence of the improved efficiency of labour.
- Improvement in the safety of farm practices.
- Helps in encouraging the youth to join farming and attract more rural people to work and live in rural areas.

Farm mechanisation in India stands at about 40-45 %. This is still low when compared to countries such as the US (95 %), Brazil (75 percent) and China (57 %). While the level mechanisation lags behind other developed countries, the level of mechanisation has seen strong growth through the last decade. The farm power availability on Indian farms has grown from 1.47 kW/ha in 2005-06 to 2.02 kW/ha in 2013-14.

In India, the level of mechanisation varies greatly by region. States in the north such as Punjab, Haryana and Uttar Pradesh have high level of mechanisation due to the highly productive land in the region as well as a declining labour force. The state governments in these states have also provided timely support in promoting mechanization of farms. The western and southern states in the country have a lower level of mechanisation due to the smaller land holdings prevalent in these regions as well as the land holding being more scattered. As a result, in many cases, mechanisation has been uneconomical leading to the lower development.

In north-eastern states, the level of mechanisation is extremely low. There are a number of reasons behind this. Factors such as hilly topography, high transportation cost, lack of state financing and other financial constraints due to socio-economic conditions and dearth of agricultural machinery manufacturing industries have hindered the growth of farm equipment sector within these states.

Operation-wise, the level of mechanisation varies from 42 percent for soil working and seed bed preparation, 29 percent for seeding and planting, 34 percent for plant protection and 37 percent for irrigation (AMMA, 2014).

Hence, it is imperative to focus on increase in *production, productivity and profitability in agriculture* by improving the intensity of farm mechanization in the country. Against the backdrop of Government's intention of doubling farm income by 2022, the emphasis has been directed towards reducing the cost of inputs, timely operations to ensure optimum crop stand within the short span of period available for crop production.

Though farm mechanization has improved the state of agriculture in certain parts of the country, it is crucial to take concrete steps to propel farmers in large numbers towards adoption of efficient, cost effective and scalable mechanization technologies. With the right focus from various stakeholders, farm mechanization has the potential to play a significant role in decreasing labor drudgery and intensiveness and increasing efficiency in farm operations.

Farm mechanization has been helpful to bring about a significant improvement in agricultural productivity by improving the efficiency in use of costly inputs. The major constraint in mechanization is that small and marginal farmers cannot afford to purchase many existing costly machineries and equipment. Small size and scattered holdings of the farmers stand in the way of mechanization. Increased fragmentation of holdings – an outcome of natural population growth as well as inadequate growth in off-farm employment opportunities – has been the bane of Indian agriculture, as it inhibits the ability of farmers to reap economies of scale and invest in mechanization. Majority of small cultivators are poor who are not able to purchase the costly machinery like tractors, combine harvesters etc. One of the main causes for the low agricultural productivity is the lack of appropriate machineries that cater to and suit the requirements of small-scale farms. It proves to be completely unviable for a small or marginal farmer to purchase farm equipment and without its usage the farmer can never sustain positive returns from agricultural output. Though subsidy is being provided for farm machinery, due to prohibitive cost and short term utility of farm machinery all farmers may not come forward to own them.

Hence, the need of the hour in improving farm productivity by improving the efficiency in use of costly inputs is two pronged- 1. provide access of all farm machinery to the small and marginal farmers through custom hiring these machineries and 2. Develop suitable small machinery to suit the requirements of small and marginal farmers.

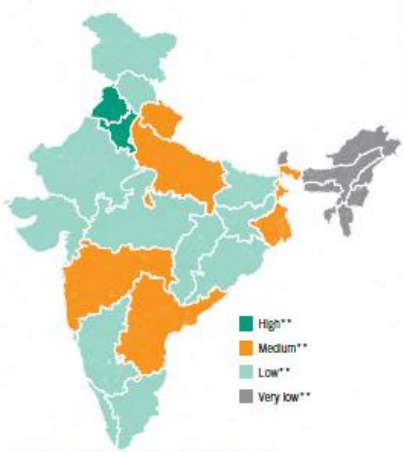

Figure 15: India relative development of mechanisation
Source: State of Indian Agriculture, Department of Agriculture report, 2012-13
** Based on relative scale of farm power availability as shown in the report

Table 4: Level of mechanisation in percent, by crop and value-chain process

Crop	Seedbed preparation	Sowing/ planting/ transplanting	Weed and pest control	Harvesting and threshing
Paddy	85-90	5-10	80-90	70-80
Wheat	90-95	80-90	70-80	80-90
Potato	90-95	80-90	80-90	70-80
Cotton	90-95	50-60	50-60	0
Maize	90-95	80-90	70-80	50-60
Gram	90-95	50-60	60-70	30-40
Sorghum	80-90	30-50	60-70	20-30
Millets	80-90	30-40	60-70	20-30
Oilseeds	80-90	30-40	60-80	20-30
Sunflower	80-90	40-50	80-90	60-70
Fodder Crop	80-90	20-40	80-90	10-20
Vegetable Crop	70-80	5-10	80-90	< 1
Horticulture Crop	60-70	30-40	40-50	< 1

Source: Country presentation paper, Agricultural Machinery Manufacturers Association (AMMA) India, October 2014

Small size and scattered holdings of the farmers stand in the way of mechanization. Increased fragmentation of holdings – an outcome of natural population growth as well as inadequate growth in off-farm employment opportunities – has been the bane of Indian agriculture, as it inhibits the ability of farmers to reap economies of scale and invest in mechanization. The average size of operational holdings in India has come down steadily from 2.28 hectare in 1970-71 to 1.33 hectare in 2000-01 and 1.23 hectare in 2005-06. The latest data show a further reduction to 1.16 hectares for 2010-11. The number of marginal small and medium operational land holdings has increased to 11.706 crore against 10.76 crore in 2005-06, while at the same time, the medium and large land holdings have shrunk to 68.56 lakh from 74.71 lakh in 2005-06.

Similar pattern is also seen in Karnataka where smaller holdings account for more than 76% in terms of number and 40% in terms of area.

Table: Land Holdings according to major size classes per 2010-11 census

Farmers (ha.)	Number of Operational Holdings ('000)	Number of Operational Holdings ('000 ha)	Average size of Operational Holdings (ha)
Marginal (0.01 to 0.99)	3849	1851	0.48
Small (1.00 to 1.99)	2138	3020	1.41
Semi-Medium (2.00 to 3.99)	1267	3393	2.68
Medium (4.00 to 9.99)	511	2904	5.69
Large (10 & above):	68	994	14.71
Total	**7832**	**12161**	**1.55**

Majority of small and marginal cultivators are poor who are not able to purchase the costly machinery like tractors, combine harvesters etc. One of the main causes for the low agricultural productivity is the lack of appropriate machineries that cater to and suit the requirements of small-scale farms. For this reason, many small farms are deemed as unproductive and inefficient. Farm mechanization plays a significant role in every nation's economy. However, it is often misconstrued to mean modernization, beneficial only to highly mechanized agriculture. Many farm machineries in use in the country, most of them imported farm machines from developed countries, are seldom appropriate for small farms. As a result of this, farm machinery generally remains underutilized. Further, due to the seasonal nature of the agriculture, the farm machinery remains idle for much of the time. Thus, idle machinery means unnecessary high costs unless proper alternate use of such machinery in the off-season is made.

Lack of access to farm power and high cost are the primary reasons for slow uptake of farm mechanization and hence non-intensification of farm productivity, particularly

among small and marginal farmers. There is a direct correlation between having access to farm implements and impact on its use efficiency, timeliness of the farm operations. It proves to be completely unviable for a small or marginal farmer to purchase farm equipment and without its usage the farmer can never sustain positive returns from agricultural output. Though subsidy is being provided for farm machinery, due to prohibitive cost of farm machinery all farmers may not come forward to own them.

In this context, establishment of Krishi Yantra Dhare programme is a boon to farmers. Krishi Yantra Dhare enables to overcome these constraints as they provide services of machinery on hire basis to farmers in right time. The special features and objectives of the programme are as under:

Special Features

- Availability of modern equipment.
- Experienced operators/drivers.
- Availability of timely service.
- Quality service.
- Service with a smile.
- Advance booking facility.

Objectives:

- To provide machineries at farm gate.
- To enhance the production and productivity of the crops
- To provide services of High- Tech machineries to small and marginal farmers in time
- To mitigate problem of labour
- Available at reasonable rentals
- To increase profitability of the farmers.

In addition to making the farm machineries which a small farmer cannot afford to purchase and use, it has been felt necessary to make available innovative farm equipment and machinery to farmers, train them in their operation, design and develop equipment for growing of various crops and study economic feasibility of identified agricultural equipment/ machinery. While GOVERNMENT OF INDIA, Ministry of Agriculture Department of Agriculture & Cooperation, Mechanisation & Technology Division has suggested agricultural machinery and equipment based on cropping pattern, there is need to develop small equipment and machinery to be used by small and marginal farmers in different regions of the country.

It is against this background, the present project of **"DESIGN AND DEVELOPMENT OF LOW COST AGRICULTURAL TOOLS AND EQUIPMENT FOR MECHANIZATION OF SMALL AND MARGINAL FARMS"** has been taken up by University of Agricultural Sciences, Raichur

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- To identify, design, development and performance evaluation of agricultural tools and equipment required for the mechanization of small and marginal farm
- To conduct large scale demonstrations of developed agricultural tools and equipment in farmers' fields of selected villages for their promotion
- To conduct training programmes on cost effective production technology of agricultural tools and equipment for small scale manufacturers, farmers and village artisans

HYPOTHESIS

The context of the evaluation arises from the following facts:

1. Small size and scattered holdings of the farmers stand in the way of mechanization. Increased fragmentation of holdings – an outcome of natural population growth as well as inadequate growth in off-farm employment opportunities – has been the bane of Indian agriculture, as it inhibits the ability of farmers to reap economies of scale and invest in mechanization.
2. Lack of access to farm power is one of the primary reasons for slow uptake of farm mechanization and hence non-intensification of farm productivity, particularly among small and marginal farmers.
3. It proves to be completely unviable for a small or marginal farmer to purchase farm equipment and without its usage the farmer can never sustain positive returns from agricultural output. Though subsidy is being provided for farm machinery, due to prohibitive cost of farm machinery all farmers may not come forward to own them.
4. In addition to making the farm machineries which a small farmer cannot afford to purchase and use, it has been felt necessary to make available innovative farm equipment and machinery to farmers, train them in their operation, design and develop equipment for growing of various crops

OBJECTIVES AND ISSUES FOR EVALUATION

The scope of evaluation is to study the impact of scheme, **"DESIGN AND DEVELOPMENT OF LOW COST AGRICULTURAL TOOLS AND EQUIPMENT FOR MECHANIZATION OF SMALL AND MARGINAL FARMS"** implemented by University of Agricultural Sciences, Raichur during the period 2010-14.

1. Stake Holders

a) University of Agricultural Sciences, Raichur – Sponsorer
b) Rashtriya Krishi Vikas Yojane – as Monitoring Authority
c) Institution of Agriculture Technologists – as Consultant
d) Farmers / beneficiaries as target group of evaluation

2. Purpose of Evaluation

Evaluation Framework

The focus of Evaluation is:

i. Review of data on design and development of new equipment for various crops and modifications of existing equipment
ii. Review of data on procurement and custom hiring of farm machinery and economic feasibilities of identified agricultural equipment/ machinery.
iii. To get feedback from farmers on usefulness and techno-economic feasibilities of various equipment.

iv. Study level of knowledge transfer to farmers.

LOG FRAME/THEORY OF CHANGE/PROGRAM THEORY

The intention of the scheme is to develop crop specific, cost effective, easy to operate and efficient and innovative farm equipment and machinery to enable farmers to take up intensive farming and provide expertise to manage higher productivity and profitability per unit area. The underlying logic is;

a. The farm machinery will help farmer in bringing in timeliness and precision to agricultural operations, greater field coverage over a short period
b. Cost effectiveness, efficiency in use of resources and applied inputs bringing precision in metering and placement of inputs, reducing available input losses, increasing efficiency of costly inputs
c. Reducing cost of production by quicker and efficient operations and minimized losses in production, processing and preparing the produce for market.
d. Last, but not the least farmers are taught to use the machinery optimally.

EVALUATION DESIGN

Evaluation design has a rationale of requirement of field level data (primary) that is required to study evaluation objective with respect to beneficiary farmers on one part and the projects taken up for study per se on the other part. The evaluation requires analysis of administration obligations under the two heads and hence a secondary data analysis becomes important and accordingly formats were designed to procure secondary data. The third obligation under evaluation is opinion of stake holders with respect to improvement of the schemes, which require group discussions and exchange of views both in the form of a format, as well as group discussions with the stake holders. The entire evaluation process required a central administration of all activities.

A core team of experts at the Institution level considered three methods to bring a meaningful evaluation of the subject, keeping in mind the scope, evaluation questions and sub-questions duly keeping its focus on the purpose of evaluation. The three methods are:

a. Accessing and analysis of secondary data from the implementing department.
b. Interaction with Principal Investigator and his team.
c. Actual visit to the project site to study and obtain necessary information to elicit answers to the evaluation questions.

DATA COLLECTION AND ANALYSIS

PROGRESS REVIEW

The following tools and equipment were developed in the project:

- Pedal operated maize sheller
- Hand operated single acting maize sheller
- Hand operated double acting maize sheller
- Push/pull type weeder cum collector
- Hand operated push type sprayer
- Manual operated multicrop thresher
- Manual operated double row planter
- Hand operated dibbler
- Standing khurpi type weeder

Pedal operated maize sheller

In our country, most of the farmers shell maize mainly by three methods namely shelling cob grain by hand; hand operated maize sheller and beating by stick. There are several electrically operated maize shelling machines for mass shelling. Mostly farmers used to take their unshelled maize cobs to such industries for shelling their maize cobs. This would increase the cost of production on account of cost incurred in transportation between farms and machine location. Dushant Meshram et al. (2019) found that dehusking and shelling are important post-harvest activities in maize crop, predominantly done by women. These activities involve a lot of drudgery as these are done manually. The maize shelling with the tool makes women's lives difficult and yields very low level of output. Moreover, dehusking as a separate activity precedes shelling that brings additional burden on farmers.

The project is mainly about generating a new concept of Maize shell (thresh) that would make easier to bring anywhere and easier to thresh Maize.

The pedal operated maize shelling machine consist of frame, power transmission system, shelling unit, extension to shelling unit, kernel collection tray, sitting arrangement for operator, safety guards and bearings. The main frame was made of MS angles and C channels, it was made heavy to have better balance and stability during pedaling. The simple bicycle chain drive mechanism was used for transmission of power. The bigger sprocket connected with the two pedals acted as driver and drives two equal size smaller sprockets were mounted on the 20 mm diameter shafts of the shelling unit. The pedaling can be easily done by the operator by sitting on the well cushioned seat of size 305×350 mm and the pedaling power gets transmitted to the shelling unit through the chain. The shelling unit actually shells out the kernels from the maize cob when rotated by pedal. The shelling was made up of MS round pipe of length 75 mm and diameter of 65 mm. The pipe

consists of four kernels detaching strips welded along the length of pipe at equal distance (90^0 apart from one another) from inside of the pipe. Eight holes of 18 mm diameter were drilled on the surface of shelling unit to facilitate easy dropping of detached kernels from shelling unit preventing chocking of shelling unit with shelled kernels of maize.

Salient features:

1. It can be operated by two labourers
2. It can be easily transported from one place to another
3. It does not require any skill either to operate or repair
4. Small children can also operate the equipment
5. No additional power is required
6. Spare parts are locally available.

Performance parameters
Shelling capacity: 72 to 75 kg/ hour
Shelling efficiency: 94-96%
Germination percentage: 86%
Cost of operation: Rs. 33 to 34/ quintal
Approximate cost: Rs. 6500

Similar pedal operated maize sheller has been designed by Pad. Dr. D. Y. Patil College of Agricultural Engineering and Technology, Talsande, Kolhapur (SB Patil et al. 2014), by Er. KARANSINH R.CHITODA, Department Of Mechanical Engineering, S.B.Patil College Of Engineering, Vangali, Indapur, Pune 413106 (Karansinh Chitoda et al, 2017), Department of Agricultural Processing & Food Engineering, College of Agricultural Engineering, Sangareddy, Telangana (G. Rajender and T. Anubabu, 2017) and also at Department of Mechanical Engineering, K.D.K. College of Engineering, Nagpur, India (Dushant Meshram et al 2019). The design and efficient parameters of the sheller are comparable.

Hand operated single and double acting maize sheller

Normally maize cobs are plucked from the standing maize crop and thereafter the maize stalk is harvested. After plucking the maize cob, it is dehusked manually and then dried in the sunshine to reduce moisture content to 15-21 percent (dry basis) for shelling to get the grain from the cob. The activity related to removal of the outer sheath from the plucked cob (called dehusking) is mostly performed by farm women.

The pedal operated maize dehusker-sheller could not reach the farmers as this was operated by two men workers due to high power requirement. Thus, an attempt was made to design, develop and fabricate a maize dehusker-sheller operated by farm women.

Performance parameters
Shelling capacity: 26 to 31 kg/hr.
Efficiency: 96 - 98 %
Germination percentage: 98.2 %
Cost of operation: Rs. 38 - 41 per quintal
Approximate cost: Rs. 2500/--

Push Pull type weeder cum collector

Weeding is one of the most important farm operations in crop production system. Weed growth is a major problem for crops particularly in cereal crops like rice and wheat, causing a considerable lower yield. Weeding is mostly performed manually that requires higher labor input and also time consuming process. Moreover, the labor requirement for weeding depends on weed flora, weed intensity, time of weeding and soil moisture at the time of weeding and efficiency of worker. Often several weedings are necessary to keep

the crop weed free. Weeds are responsible for significant crop yield losses and for financial losses in agricultural production – in the order of 10% per year worldwide (Oerke, 2006). In India the annual losses due to weeds in food grains is about 82 million tons, pulse 14 million tons, oil seeds 12 million tons and commercial crops about 52 million tons (P. K. Singh, 2013). Weeding is a time consuming and labour intensive operation which accounts for about 25 % of the total labour requirement (900–1200 man-hours/hectare) during a cultivation (Yadav and Pund, 2007).

Weeding is generally done 15-20 days after sowing. The weed should be controlled and eliminated at their early stage. Depending upon the weed density, 20-30% percent loss in grain yield is quite usual which might increase up to 80 percent if adequate crop management practice is not observed (Gunasena and Arceo, 1981). Weeds compete with crop plants for nutrients and other growth factors and in the absence of an effective control measure, remove 30 to 40 percent of applied nutrients resulting in significant yield reduction (Dryden and Krishnamurthy, 1977). Delay and negligence in weeding operation affect the crop yield and the loss in crop yield due to weeds in upland crops vary from 40-60% and in many cases cause complete crop failure (Singh, 1988).

Timely weeding is very much essential for a good yield and this can only be achieved by using mechanical weeders which can reduce the time spent on weeding (man-hours), cost of weeding and drudgery involved in manual weeding. Mechanical weed control not only uproots the weeds between the crop rows but also keeps the soil surface loose, ensuring better soil aeration and water intake capacity. Manual weeding can give a clean weeding but it is a slow process (Biswas, 1990). As the time period available for weeding is limited, improved mechanical weeders are to be used to complete the weeding operation in due time at less cost. At present, different designs of weeders are available. All these designs are locally made and region specific to meet the requirements of soil type, crop grown, cropping pattern and availability of local resources. These locally manufactured weeders do not maintain adequate design for minimum force requirement and either suffering with less penetrability or sinking in the soft soil.

Push pull type weeder cum collector is a manually operated weeder suitable for operation between the crop rows. It consists of a bicycle wheel which is attached by welding to a hoe with teeth. The hoe has a small wheel attached. A carrier is attached to the bicycle wheel by horizontal rods assembly. The hoe is attached to a handle by two mild steel rods. The complete assembly is made of mild steel. The hoe with tines follows the roller assembly. The height of the hoe can be adjusted according to the working depth. The arms are joined to the handle assembly, which is made from thin walled pipes. The height of the handle can also be adjusted according to the requirement of the operator. For removing weeds it is repeatedly pushed and pulled in between the crop rows in the standing position. There is a small hook attached to the bicycle wheel assembly in the front

to which a rope can be tied to pull the weeder. One person can pull the weeder while another can push the weeder using the handle. The tines penetrate into the soil and the rolling action pulverize the soil. The tines in the push mode penetrate into the soil and cuts or uproots the weeds which can be collected and put in the tray carrier.

Salient features:

1. It can be operated by either one or two laborers.
2. Height and angle of the blade can be adjusted as required.
3. Weeds so collected in the collector can be taken out of the field in basket.
4. Blade can easily be replaced as required.
5. Easy to transport from one place to another place.
6. No kill is required either to operate or repair.
7. Gives very good exercise also.
8. No power source is required.
9. Spare parts are available in local market.

Performance parameters:

Capacity	:	1 – 1.5 acre/day (8 hours)
Efficiency	:	86 – 91 %
Cost of operation	:	Rs. 200 – 250/acre
Approximate cost	:	Rs. 1300/--

Hand operated push type sprayer

Traditionally, farmers are using backpack sprayer which is hand operated portable machine. Labour has to carry the weight of pesticide filled tank on their back which causes fatigue to labour and hence reduces the human capacity. Based on survey reports of farmers, gardeners and researchers, the following problems are found in current available pesticide spraying machine.

1. It leads to severe problems of back pain to farmers.
2. It requires more time to spray pesticide over a wide area of farm land.

3. Some innovative sprayers are also developed but they occupy large space which is main drawback.
4. Existing modern sprayers also leads to wastage of pesticides on fields.
5. It requires more time to spray pesticide over a wide area of farm land; they are not adjustable in sense of height, and not suitable for Indian style of farming.
6. They require fuel for their working

Salient features:

1. It can be operated by one labourer
2. Height of the boom can be adjusted as required
3. Spacing between two nozzles can be adjusted according to row spacing
4. The capacity of sprayer tank is 20 litres
5. Width of the transporting wheels can be adjusted from 2 to 4 ft
6. Hand lever can be operated continuously along with transportation
7. Can easily be transported from one place to another place
8. No skill is required either to operate or repair
9. No power source is required
10. Spare parts are available in local market

Performance parameters:

Spraying capacity : 25 – 30 lit/hr.
Efficiency : 88 – 92 %
Cost of operation : Rs 150 – 175 / acre
Approximate cost : Rs. 8000/--

Manual operated multicrop thresher

The operation of detaching the grains from the ear head, cob or pod is called threshing. It is basically the removal of grains from the plant by striking, treading or rupturing. The traditional method of threshing using manual labourers requires 150-230 man-h/ha. Threshing is normally done after the grain moisture content is reduced to 15 to 17%. In various parts of world, threshing is accomplished by treading the grains under the

feet of animals or under the tractor tyres, striking the grains with sticks, pegs or loops and removing the grains by rubbing between stone or wooden rollers on a threshing floor or between the rasp bar and a concave of combine. The threshing can be achieved by three methods: Rubbing action, Impact and Stripping.

Timeliness is very crucial in all farm operations in general and in threshing particularly. Slightly delay in threshing operation may lead to tremendous loss in production, productivity and sometimes quality of the grains.

Threshers are the most important component of farm mechanization. If threshing is not done timely, all efforts made by farmers and inputs given to crop goes wasted. Traditional method of threshing by animal is very slow. It gives low output. Due to low output, the cost of operation is high and there is a huge loss of grains because of rodents, birds, insects, wind, and untimely rain and fire hazards.

In India various types of threshers namely Multicrop thresher, Paddy thresher, High capacity multicrop thresher, Pigeon pea thresher, Semi-axial flow multicrop thresher, Groundnut thresher, Sunflower thresher, Single earhead thresher, Maize thresher etc. are used for threshing of various crops. Among these threshers, multicrop thresher with medium and high capacity are most common. These threshers can be used for various crops with little adjustments in cylinder speed and clearance between cylinder and concave. These threshers provide good quality grains for seeding and human consumption as well as bhusa for animal feed. The losses during operation are also in the range of 0.5 – 3.0 % with broken grains 0.2 – 1.4 % which are in the acceptable range of BIS standard.

The multi-crop threshers which are used to handle number of crops are highly successful for threshing cereal crops and pulses. The advantage of multicrop threshers is that with minor adjustments it can be used to thresh different crops, whereas other threshers can thresh a particular crop only. In efficient threshing not only requires substantial time but also cause considerable threshing losses of grain. An improved mechanical thresher would improve timelines of operation and also reduce threshing related losses.

Salient features:

1. It can be operated by two labourers
2. It can be used for threshing of jawar, bajra and green gram
3. Can easily be transported from one place to another place by cycling
4. Once season is over it can be used for transportation
5. RPM of the threshing drum and concave clearance can be adjusted as required
6. Hand lever can be operated continuously along with transportation
7. No power source is required

8. No skill is required either to operate or repair
9. Spare parts are available in local market

Performance parameters:

Threshing capacity	: 45-50 kg/hr.
Efficiency	: 87 – 92 %
Cost of operation	: Rs. 40 – 43 / quintal
Approximate cost	: Rs. 15500/--

Manual operated double row planter

Manual method of seed planting, results in low seed placement, spacing efficiencies and serious back ache for the farmer which limits the size of field that can be planted. However, planting machine or planter that is normally required to produce more food is beyond the buying capacity of small holder farmers (Kalay khan et al, 2015).

These small holder farmers still continue to plant manually, the result of which is low productivity of the crops. It is therefore necessary to develop a low cost planter that will reduce tedium and drudgery and enable small holder farmer to produce more foods and also environmental friendly(Bamgboye, A.I and Mofolasayo, A.S 2006).

In the past, various types of design have been developed with different design approaches which have their advantages and disadvantages and also operational limitations. The performance of the drills was satisfactory as long as the seed was placed into adequate soil moisture. Kumar et, at. (1986) developed a manually operated seeding attachment for an animal drawn cultivator. The seed rate was 43.2 kg/hr. while the field capacity was 0.282 ha/hr. Tests showed minimal seed damage with good performance for wheat and barley. Adisa and Braide (2012) developed template row crop planter.

Bamgboye and Mofolasayo (2006) developed a manually operated two-row Okra planter. The field efficiency and field capacity were 71.75% and 0.36 ha/hr. while seed rate

was 0.36kg/hr. with low average seed damage of 3.51%. Gupta and Herwanto (1992) designed and fabricate a direct paddy seeder to match a two wheel tractor. The machine had a field capacity of about 0.5 ha/hr. at a forward speed of 0.81mls, and there was no damage caused by the metering mechanism for soaked seeds; though 3% damage was recorded for pre- germinated seeds.

The basic objective of sowing operation is to put the seed and fertilizer in rows at desired depth and seed to seed spacing, cover the seeds with soil and provide proper compaction over the seed. The recommended seed to seed spacing and depth of seed placement vary from crop to crop and for different agro-climate conditions to achieve optimum yields

Salient features:

1. It can be operated by one labourer
2. It can be used for sowing jawar, bajra and green gram
3. Can be easily transported from one place to another place
4. The spacing between plant to plant can be maintained by replacing seed metering disc
5. Fertilizer can be applied along with seeding
6. Spacing between rows can be adjusted
7. Seed covering blade can be fixed behind furrow openers
8. No skill is required either to operate or repair
9. Spare parts are available in local market

Performance parameters:

Field capacity : 1.5 – 2.0 acre/day (8 hours)
Efficiency : 83.5 – 87 %
Cost of operation : Rs. 300 – 350 / acre
Approximate cost : Rs. 2500/--

Hand operated dibbler

In agriculture, precision seeding is a method that involves placing seed at a precise spacing and depth. This is in contrast to broadcast seeding, where seed is scattered over an area. Although precise hand placement would qualify, precision seeding usually refers to a mechanical process. A wide range of hand-push and powered precision seeders are available for small- to large-scale jobs. Using a variety of actions, they all open the soil, place the seed, then cover it, to create rows. The depth and spacing vary depending on the type of crop and the desired plant density. However, there are few farmers who still perform precision seeding manually. These are the farmers who cannot afford to buy tractors. Thus, in order to overcome this problem, a manual seed dribbler has to be designed, which saves seeds and avoids crowding. The objective is to design an efficient seed dribbler overcoming the problems in the previous version of it.

Considerations:

1. Soil types: could be sticky or dry
2. Seed types: based on different types of seed, the seed size, the seed spacing and seed depth keeps varying; this should be considered while designing the seed dribbler. Thus, correct seed rate should be obtained while dribbling a particular seed type. Prof. Anil Gupta suggested using gears to control the seed rate.
3. Methods: comparing the methods used before and that used presently in listing the problems faced (failures) while dribbling and also understanding the reason behind its success. This is also to compare the cost and know what the farmers can afford.
4. Safety and health issues: understand the problems faced when sowing of seeds is done manually
5. Fertilizers: dribbler can be used for multitasking by the farmer to ease the work. The dribbler can also be used to put fertilizers along with sowing of seeds (many suggestions were received for this consideration)
6. Material: Normally the dribblers are quite heavy. It is desirable to make the dribbler with different materials to make it light and easy to carry. Also durability and portability of the material is to be taken into consideration
7. Areas and terrains: crop type changes depending on areas and the terrain can be steep or flat.

Some additional considerations:

Labour: To know the gender and age group of the labour who can use the dribbler, we need to consider the height of the dribbler, thus taking into consideration the adjustable length of the dribbler.

Continuous and discontinuous process: The dribbler can be used as continuous or discontinuous depending on type of seed.

Maintenance: Materials which are easily available and easy to maintain should be considered and overall seed dribbler is easy to maintain.

Field capacity : 1.5 to 1.8 acre/day (8 hours)
Efficiency : 85.8 – 88.5 %
Cost of operation : Rs. 180 – 250 per acre
Approximate cost : Rs. 800/--

Standing khurpi type weeder

The traditional method of weed control is to remove the weed manually by a Khurpi or Spade. This is a very time consuming process. Due to shortage of agricultural labour in peak season, farmers cannot compete weeding in time.

The khurpi also known as a hand hoe is most commonly used hand tool for weeding. The tool is used in squatting position. The khurpi consists of a sharp, straight-edged metallic blade with a tang embedded into a wooden handle. The blade and a tang are forged in single piece to a shape from medium or high carbon steel. In some cases, alloy steel (nickel, chromium or molybdenum or manganese) is also used for the fabrication of blade. The cutting edge is hardened and sharpened. The tang is joined to the wooden handle with the help of rivets. The shape and design of the khurpi are region or location specific depending upon the soil and cultural practices. For operation, the khurpi is held in one hand and pushed into the soil for removal of weeds or unwanted plants. The cutting or uprooting of the weed or undesired plant takes place due to shear and impact action of the blade of the khurpi.

As weeding with khurpi is done in squatting position, it causes a very high Body Part Discomfort according to Premkumari et al, 2018. The majority of discomfort was observed at left shoulder, right shoulder, left arm, right arm, upper back, lower back right thigh and left thigh for all the subjects while weeding with khurpi. This was because of squatting posture and use of wrist during the operation. The work rate for various weeding implements vary due to variation in crop growth, row and plant spacings, weed intensity, soil conditions and other factors. Typical work rates of Khurpi varies from 300-500 man-h/ha.

Mechanical weeding keeps the soil surface loose, which results in better aeration and moisture conservation. In our country the average land is about 0.5 ha/farmer so, the use of power weeder is not economical and also it is not useful because in standing crop we have to maintain the row to row as well as plant to plant distance. The use of power weeder gives better yield but it is very costly and our farmer cannot afford it (Satish Kumar et al, 2017). Hence, looking for a manual weeder with higher efficiency than a khurpi is a better option.

As the intercultivating tools are used in cropped fields, they are to be operated with great care, lest they damage the young plants. The benefit of using improved weeding tools are, reduction in time requirement, reduction in human effort and effectiveness of operation. The time saved by use of these implements may be utilized in better care and management of crop.

Long handle standing khurpi type weeder tools have a soil working tool mounted at the end of a 1.5 to 2 m long steel/ aluminum/ wooden/ bamboo handle. These tools are operated in push or push-pull or pull mode and in standing posture. The soil working tool consists of one or more blades of different shape and size mounted on tines which in turn are fixed on a socket for fitting to the handle. The common shapes of blades on these weeders are straight, convex, V -shape, sweep, serrated, etc. These weeders weigh 1.5 to 2.5 kg. These are designed to work under friable soil moisture conditions and give high work output at the early stages of crop growth when weeds are small.

Operation of the push-pull type weeder along the row in typical conditions requires 100-125 man-h/ha compared to typical work rates of hand hoe (Khurpi) which varies from 300-500 man-h/ha. Premkumari et al 2018 found that standing khurpi type weeder is best for agricultural workers for weeding operation which reduces the physical discomfort.

Field capacity: 0.8 to 1.1 acre/day (8 hours)
Efficiency: 84.6 – 86.0 %
Cost of operation: Rs. 200 – 230 per acre
Approximate cost: Rs. 700/--

FINDINGS AND DISCUSSION

The mechanization of agriculture that took place during the 20th century led to major changes in how farmers plant, irrigate and harvest crops. Combines, tractors, harvesters and other machinery have enabled farmers to increase their production while relying less upon an extended labor force. In other words, agricultural mechanization is the process whereby equipment, machineries and implements are utilized to boost agricultural and food production. It is the application of machineries, equipment and implements in the day to day farm activities to increase marginal output in food production and poverty eradication. Agricultural mechanization reduces drudgery which hitherto makes it difficult for large scale food production and which has also been making it difficult for nations who have to meet their food requirements for the teeming population. In order to solve the problem of drudgery and other problems associated with food production, various measures have been introduced to combat these problems through mechanization. Agricultural mechanization involves the design, manufacture, distribution, use and servicing of all types of agricultural tools, equipment and machines. The efficiency of mechanization can be judged from the fact that modern plough is about 200 to 300 % efficient than indigenous plough, efficient machinery helps in increasing productivity by about 30% besides enabling the farmers to raise a second crop or multi crop making the Indian agriculture attractive and a way of life by becoming commercial instead of subsistence.

Innovation in farm machinery sector will drive the next phase of agricultural growth in the country, with focus on spreading farm mechanization to small and marginal farmers and regions that have low farm power availability. As a result, Indian farmer is fast adapting farm mechanization than ever before. The agriculture equipment market in India is presently valued at 6.5 billion USD and has enormous potential for further growth. The tractor market is expected to grow at a CAGR of 8-9 % in next five years. The joint efforts made by Government and farm equipment industry in the country have led to such progress in mechanization over the years (Arun Khurana, 2020). Research and development efforts and approaches in agricultural mechanization in India have been directed towards finding cost-effective solutions to location-specific problems of agriculture.

Considering the above, the efforts made by University of Agricultural Sciences, Raichur are noteworthy.

However, there is need to critically examine the efficiency of equipment being used presently in cultivation of the major crops in the area of operation of the University of Agricultural Sciences, Raichur including Bidar, Kalaburgi, Yadgir, Raichur, Ballari and Koppal. Suitable steps may be taken to develop/ modify the equipment to reduce the

drudgery of work, improve efficiency leading to improvement on production and productivity. This will go a long way in adoption of precision farming practices to improve farmers' income.

No scientific and systematic evaluation on the efficiency and economic feasibility of the machineries developed/ modified by UAS, Raichur has been made. This would have thrown light on the usefulness of the new machineries developed/ modified. In the absence of this information, acceptance of the machineries by farmers and their popularization will be difficult.

While the pedal operated and to some extent manual single and double cob maize shellers are better that the traditional methods of shelling, their usefulness appears to be doubtful as they do not do away with human drudgery. The farmers are more inclined to hire power driven maize shellers which are more efficient and more time saving. Use of power driven maize shellers has become a regular practice in most maize growing areas of the state.

The weeders developed are noteworthy and have to be popularized in the area through field demonstrations and commercial production.

The dibbler developed will be useful especially in cotton crop where manual planting of seeds has many a times resulted in low/ thin crop stands due to planting done at different depths by labourers. The equipment needs to be popularized among farmers.

The solar power operated sprayer developed is a useful innovation and needs to be popularized through Public Private Participation mode.

REFLECTIONS AND CONCLUSIONS

1. More efforts are required by UAS, Raichur to demonstrate the equipment in association with Karnataka State Department of Agriculture and Department of Horticulture. These machines have to be added in the Custom Hire Service Centres and leased to farmers to improve their popularity and usage. More publicity for newly developed equipment through both print and electronic media is required to make them popular and for wider usage. KSDA and Department of Horticulture should chalk out the strategy to popularize the equipment by way of including the equipment through existing various subsidy schemes. (All District Mechanization Programmes already adopted for bullock drawn implement and small implement)
2. The comparative cost efficiency of all equipment vis a vis the traditional equipment and manual labour have not been carried out systematically and scientifically. This would have thrown light on economic advantages of using the newly developed equipment.
3. There is need for creating and documenting scientific data base on equipment efficiency in terms of
    i. Fuel efficiency/ time efficiency
    ii. Reducing drudgery
    iii. Duraion of operation, i.e., area covered, equipment's overall efficiency, soil condition etc.
    iv. Cost of cultivation compared to conventional methods, i.e., economics of operations and savings needs to be worked out.
    v. Life span of equipment
4. UAS, Raichur should attempt to apply and obtain patent for the new machinery and commercialize the equipment through tie up with farm machinery manufacturers for mass production of the machinery. There is need for creation of brand name for equipment developed.
5. There is need to design regular training programmes to educate the farmers on upkeep, maintenance and repairs of the farm machinery developed.
6. There is need of Human resource developed in terms of use of machinery in Agriculture. The Agri Diploma graduates may be trained in maintenance of Farm power and machinery for skill development on EARN WHILE YOU LEARN mode.
7. At present, the machinery developed under the project may be compared with the power (1-3.5 KW) operated machinery commercially available and already under Government programmes and may be introduced in custom hiring center under Krishi Yantra Dhare scheme to mechanize farm operations suitable for small and marginal farmers.
8. A core team of experts at the Institution level to identify the developed equipment as a women friendly equipment and policy support from University to popularize among farmers.

9. To support women friendly equipment, University may post one of the subject matter specialists and an Agricultural Engineering expert in all KVKs and popularise the equipment through FLD/Training to propel small and marginal farmers towards adoption of these equipment to reduce drudgery in farm operations.

ACTION POINTS

1. While commendable efforts have been made to develop cost effective low cost equipment to carry out various farm operations, the performance evaluation of the equipment could have thrown better light on efficiency of the equipment.
2. The project is silent on the information on adoption of the equipment developed under the project by farmers. There is need to evaluate the performance of the equipment in farmers' fields and take up commercial production for use by farmers in PPP mode.
3. Although the equipment developed are said to reduce the drudgery of agricultural operations, efforts are needed to popularize their use through demonstrations in farmers' fields. Hence there is need for convergence of line departments like Karnataka State Department of Agriculture and Horticulture.
4. There is need to list the major farm operations in the major crops of the area and examine the efficiency of the equipment being presently used in these crops for different farm operations and need for development of new equipment. Present study has mostly concentrated on maize and cotton crops although in the area of operation of the University many other important crops like pigeon pea, soybean, green gram, black gram, paddy and Bengal gram are grown commercially. There is need to review the usefulness of the equipment presently being used in these crops.
5. There is need for working out drudgery reduction and cost of covering the cultivable one acre of land (i.e., Benefit Cost Ratio to be worked out).
6. The viability and impact of small low cost agricultural tools and equipment by small farmers is not viable for which the project should continue on PPP mode.
7. There is need to work out the durability/ longevity of the equipment besides economics.
8. Manpower requirement/ training is needed in order to improve the use and efficiency of equipment leading to reduction in cost of production and enhancing the profitability of farmers.
9. KSDA and Department of Horticulture should chalk out strategies to popularize the equipment by way of including the equipment in various existing subsidy schemes (particularly in all district mechanization programmes to be supported by ZP).
10. There is need for developing simple machinery with multiple use at farmer's field with cost effective attachments.
11. Light weight and strong materials non-corrosive in nature should be used in designing and developing new equipment for which collaboration with Defence Research and Development Organization (DRDO), Hyderabad may be sought.
12. The impact of conducting training programmes and the feedback from trainees needs to be documents.
13. The project has not documented the role of local artisans. They should be trained in developing new equipment.

References:

Adisa A F, Braide F. G, 2012, "Design And Development of Template Row Planter", *Transnational Journal of Science and Technology*, August 2012 edition vol. 2, No.7 Agricultural Machinery Manufacturers Association (AMMA) India, October 2014, Country presentation paper

Arun Khurana, 2020, Agricultural Mechanization: Need of the Hour for Enhanced Productivity, *Employment News*, 14-03-2020 to 20-03-2020

Biswas, H. S. (1990): Soil tool interactions for mechanical control of weeds in black soils. Unpublished Ph.D. thesis, Indian Institute of Technology, Kharagpur

Bamgboye, A.I and Mofolasayo, A.S 2006. "Performance Evaluation of a Two-Row Okra Planter". *Agricultural Engineering International: the CIGR Ejamal*. Manuscript PM 06002. Vol.viii. July.

Dryden, R.D. and C. H. Krishnamurthy, (1977): Year round tillage, *Indian Journal of Weed Science*, 9: 14-18.

Dhiraj N. Kumbhare, Vishal Singh, PrashikWaghmare, Altaf Ansari, Vikas Tiwari, Prof. R.D. Gorle, 2016, " Fabrication of Automatic Pesticides Spraying Machine" *International Research Journal of Engineering and Technology (IRJET)* e-ISSN: 2395 -0056 Volume: 03 Issue: 04 | Apr-2016

Dushant U Meshram, Handa CC, Hande AS, 2019, A review on design and development of pedal operated maize sheller, *International Research Journal of Engineering and Technology*, Volume: 06 Issue: 06 | June 2019

FICCI, 2017, Transforming Agriculture Through Mechanisation, A Knowledge Paper on Indian farm equipment sector

M. A. Gaodi, A. S. Lonkar, A. S. Wankhede, S. D.2016, Development of multipurpose sprayer- a review, *International Research Journal of Engineering and Technology (IRJET)*Volume: 03 Issue: 03 | Mar-2016

Gunasena, H.P.M. and L. M. Arceo, (1981): Weed control studies with butachlor in direct seeded rice in Shri Lawlea, Proceedings of 8th Asian Pacific weed science society conference, Bangalore, India, November 27-29.

Gupta, R.K. and Sayre K.D. 2007. Conservation agriculture in South Asia. *J. Agril. Sci.* 145: 207-214.

Kalay khan, S.C. Moses, Ashok kumar "A Survey on the Design, Fabrication and Utilization of Different Crops Planter" *European Academic Research* - vol. iii, July 2015.

Karansinh R Chitoda, Kalpak V Doshi, Sourabh A Dugad, Nitin T Kadam and Paval KL, 2017, Design and Development of Pedal Operated Maize Desheller – A review, *International Journal of Innovations in Engineering Research and Technology,* VOLUME 4, ISSUE 2, Feb.-2017

Kumar, K, Naresh N.K. and Ojha, T.P. 1986. "Design, construction and Performance of a manually- operated seeding attachment for an animal drawn cultivator".

Agricultural Mechanization in Asia, Africa and Latin America. Vol.17, No.2, pp.35-38.

Premkumari, Devanand Maski, M. Veerangouda and Sunil Shirwal, 2018, Evaluation of Body Discomfort Score of Agricultural Worker during Weeding Operation, *Int.J.Curr.Microbiol.App.Sci* (2018) 7(10): 365-373

G. Rajender and T. Anubabu, 2017, Development and Performance evaluation of pedal operated maize sheller, *International Journal of Agricultural Science and Research (IJASR)* ISSN(P): 2250-0057; ISSN(E): 2321-0087 Vol. 7, Issue 2, Apr 2017, 547-554

Oerke EC. 2006. Crop losses to pests. *J Agric Sci* 144(1): 31 –43.

Rajashekhargoud, Angadi, Rohit L G, Satish Changond, Santosh Kagale, 2017, "Cam Operated Agrochemical Pesticide Sprayer" *International Journal of Engineering Research & Technology (IJERT)* ISSN: 2278-0181 Vol. 6 Issue 01, January2017

Rangaswamy, (1993): Evaluation of power weeder performance. *Agricultural Mechanization in Asia, Africa & Latin America* 24(4): 16-18.

Sandeep H. Poratkar, Dhanraj R. Raut, 2013, "Development of Multinozzle Pesticides Sprayer Pump" *International Journal of Modern Engineering Research (IJMER)* Vol.3, Issue.2, March-April. 2013

Satish Kumar, Ashok Kumar and Sanoj Kumar, 2017, Performance Evaluation of Developed Manually Operated Rotary Weeder for Vegetable Crops, *Int.J.Curr.Microbiol.App.Sci* (2017) 6(11): 4012-4019

S. B. Patil, A. D. Chendake, M. A. Patil, S. G. Pawar, R. V. Salunkhe, S. S. Burkul, 2014, Development and performance evaluation of pedal operated maize sheller, *International Journal of Advanced Research* (2014), Volume 2, Issue 9, 561-567

Shivarajakumar, Parameswaramurthy. "Design and development of wheel and pedal operated sprayer", *IPASJ International Journal.* Volume 2, Issue 6, June 2014

Singh, G. (1988): Development and fabrication techniques of improved grubber. *Agricultural Mechanization in Asia, Africa and Latin America*, 19(2): 42-46.

Singh P. K. Introduction to Weed Science and Challenges. CAFT on Agro -ecological Approaches towards Sustainable Agricultural Production from 01 -21 Oct. 2013

Shreemat Shreshta, 2017, 'Testing of hand tools and non-motorised machines used in agriculture in the Asia Pacific region', Agricultural Engineering Division, Nepal Agricultural Research Council, available on UNESCAP CSAM website

Yadav R, S. Pund (2007). Development and ergonomic evaluation of manual weeder. Agricultural Engineering International: the CIGR E journal. Manuscript PM 07 022. 9: 1 - 9.

TERMS OF REFERENCE

FOR EVALUATION OF THE PROJECT ENTITLED "DESIGN AND DEVELOPMENT OF LOWCOST AGRICULTURAL TOOLS AND EQUIPMENTS FOR MECHANIZATION OF SMALL AND MARGINAL FARMS" IMPLEMENTED DURING 2010-11 TO 2013-14 BY THE UNIVERSITY OF AGRICULTURAL SCIENCES, RAICHUR AT THE COLLEGE OF AGRICULTURAL ENGINEERING, RAICHUR.

1. Title of the Study: "Design and Development of Low Cost Agricultural Tools and Equipments for Mechanization of Small and Marginal Farms"

2. Department/Agency implementing the Scheme: **Department of Farm Machinery and Power Engineering**, College of Agricultural Engineering, UAS, Raichur.

3. Project approval No. (Sector): PMC/RKVY/4th SLSC/2009-10 Dtd:15-02-2010

Year of start : 2010-11

Year of conclusion: 2014

Total budget of the project: 50.00 lakhs

4. Background and the Context:

Sustainable and continuous development is of vary prime concern in the long-term interest of Indian agriculture. Of the total cultivated area of 143.8 million hectare in the country, the dry land area accounts for 89 million hectare (63%) and contributes to about 42-44% of total food production and provides livelihood to about 500 million people. Indian agriculture is very complex, risk prone and it is characterized by levels of low productivity due to low input uses. Dry land agriculture is spread throughout the length and breadth of the country with semi-arid to sub-humid environments, shallow light soils to deep black and alluvial soils with varied crop growing period ranging from 90 to 200 days. Karnataka is not exceptional to this scenario. Drought tolerant crops such as groundnut, cotton, sorghum, redgram, finger millets and oil seeds etc. are generally grown in these regions. These crops usually have poor growth and development, resulting in reduced yields.

Sustainable production and productivity, particularly, in rainfed areas can be achieved through improvement of land use pattern, farm mechanization, soil and water conservation and better management. Productivity of rainfed crops is very low on account of poor fertility, erratic weather conditions, poor farming infrastructure, short growing season and subsistence farming carried out by the farmers. Mechanization of agriculture plays a very important role in enhancing the production and productivity. It is needed for the development and optimal utilization of natural resources leading to higher productivity and reduced cost of production for greater profitability, economic competitiveness and

sustainability. It helps the farmers to achieve timeliness in farm operations and apply costly inputs with reduced quantity for better efficacy and efficiency.

Agricultural mechanization by developing small manually operated eco-friendly without using any power source would greatly reduce the growing agricultural labour shortage, input/operational cost, drudgery in agricultural operation and help in taking up timely operation, thereby would facilitate the protection and production of crops. Further, this would help in minimizing the harvest and post harvest losses. Hence, keeping above factors in view a project entitled 'Design and Development of Low Cost Agricultural Tools and Equipments for Mechanization of Small and Marginal Farms' was submitted to the RKVY Cell, Government of Karnataka and sanctioned under the RKVY grants during 2010-11.

5. Objectives:

1. To identify, design, development and performance evaluation of agricultural tools and equipment required for the mechanization of small and marginal farm.
2. To conduct large scale demonstrations of developed agricultural tools and equipments in farmers' fields of selected villages for their promotion.
3. To conduct training programmes on cost effective production technology of agricultural tools and equipment for small scale manufacturers, farmers and village artisans.

6. Present Status of the Project: Completed / Concluded

7. Outcome of the Project:

The following agricultural tools and equipments suitable for mechanization of small and marginal farm holdings have been developed and demonstrated.

i. Pedal operated maize sheller
ii. Hand operated single acting maize sheller
iii. Hand operated double acting maize sheller
iv. Push/pull type weeder cum collector
v. Hand operated push type sprayer
vi. Manually operated push/pull type two row multicrop planter
vii. Tricycle mounted pedal operated multicrop thresher

8. Assets : Include building, eqipments - all the assets purchased under the project.

Sl. No.	Name of the asset	Date of purchase	Qty. (Nos.)	Total cost (Rs.)	Purpose of purchase
1	½ Hp Induction motor	8/10/2010	1	4,900=00	For implementation of technical programme of the project for development of tools and farm equipment suitable for mechanization of small and marginal farm holdings
2	One Hp Induction motor	8/10/2010	1	5,800=00	
3	Sheet sheering machine size 16"	25/11/2010	1	15,400=00	
4	Digital anemometer (hand operated)	25/11/2010	1	9,790=00	
5	Bench wise 6"	25/11/2010	8	43,200=00	
6	Hand drilling machine 1/2"	25/11/2010	1	4,800=00	
7	Surface plate (size 2" x 2")	25/11/2010	1	4800=00	
8	Digital seed moisture meter	30/11/2010	1	11,500=00	
9	Torque meter (15 kg cm)	1/12/2010	1	42,500=00	
10	C clamp (8")	1/12/2010	3	4,200=00	
11	Flat plate (14")	1/12/2010	12	5,640=00	
12	Hammer (one pound)	1/12/2010	4	1,160=00	
13	Hammer (1.5 pound)	1/12/2010	4	1,560=00	
14	Hand tape (3/4")	1/12/2010	2	2,560=00	
15	Hand tape (5/16")	1/12/2010	2	900=00	
16	Hand tape (1/2")	1/12/2010	2	1,600=00	
17	Hand tape (1/4")	1/12/2010	4	2,400=00	
18	Hand tape (3/18")	1/12/2010	4	3,600=00	
19	Hand tape (1")	1/12/2010	1	2,900=00	
20	Blower (hand operated)	1/12/2010	1	2,450=00	
21	Blower (motorised) ½ Hp	1/12/2010	1	14,800=00	
22	Mechanical Tachometer	3/12/2010	1	12,900=00	
23	Maize Sheller (Tubular, plastic)	3/12/2010	10	600=00	
24	Sickle	4/12/2010	2	120=00	
25	Taskalfa -180- digital copier with printer	22/01/2011	1	80,448=00	
26	Sheet bending machine	27/1/2011	1	86,000=00	
27	Hp desk top computer	01/02/2011	2	66,812=00	
28	Cycle wheel attached push type weeder	5/2/2011	25	32,500=00	
29	Hand operated double acting maize sheller	5/2/2011	20	60,000=00	
30	Pedal operated double acting maize sheller	13/2/2011	10	78,000=00	
31	Hand operated single acting maize sheller	13/12/2011	20	16,000=00	
32	Try cycle mounted pedal operated multicrop thresher	15/2/2011	4	15,500=00	

Sl. No.	Name of the asset	Date of purchase	Qty. (Nos.)	Total cost (Rs.)	Purpose of purchase
33	Cycle wheel mounted hand operated push sprayer	15/2/2011	5	35,000=00	
34	Batteries charger (6 batteries charger)	16/3/2011	1	15,000=00	
35	Lafayette anthropometric set	17/3/2011	One set	99,750=00	
36	Heart rate monitor	17/3/2011	One set	41,425=00	
37	Digital back and leg dynamometer	23/3/2011	One set	99,225=00	
38	Digital hand grip dynamometer	24/3/2011	One set	96,600=00	
39	File round 10"	14/1/2012	10	3,100=00	
40	File flat 14 "	14/1/2012	10	5,500=00	
41	File half round 10"	14/1/2012	10	5,900=00	
42	Pipe vice	14/1/2012	2	2,700=00	
43	Welding cable	14/1/2012	30 m	7,200=00	
44	Shearing machine	14/1/2012	1	15,400=00	
45	Carpentry bench vice	14/1/2012	10	14,250=00	
46	Screw driver set	14/1/2012	2	850=00	
47	Zig saw machine block	14/1/2012	5	340=00	
48	Sheet cutter hand operated 9"	14/1/2012	2	8,100=00	
49	Digital Tachometer (contact and non-contact)	14/1/2012	2	7700=00	
50	Spirit level	14/1/2012	2	260=00	
51	Pipe wrench spanner	14/1/2012	2	980=00	
52	Bevel protractor	14/1/2012	2	6,600=00	
53	Wire gauge	14/1/2012	2	950=00	
54	Power metal cutter	14/1/2012	1	9,950=00	
55	Hand grinding machine	14/1/2012	1	3,700=00	
56	Spanner set (6 to 32)	14/1/2012	1	975=00	
57	Ring spanner set (6 to 32)	14/1/2012	1	1,900=00	
58	L and key set	14/1/2012	2	1,200=00	
59	Battery cell tester	14/1/2012	2	1,800=00	
60	Bench vice 5"	14/1/2012	8	36,000=00	
61	C clamp 4"	14/1/2012	8	4,800=00	
62	Single phase welding machine with 3 meter copper cable and holder	14/1/2012	1	15,800=00	

Sl. No.	Name of the asset	Date of purchase	Qty. (Nos.)	Total cost (Rs.)	Purpose of purchase
63	File triangular	14/1/2012	10	4,960=00	
64	Air compressor tank (200 pounds)	17/1/2012	1	33,100=00	
65	Pipe bending machine	17/1/2012	1	39,000=00	
66	Push type standing weeder	23/2/2012	75	88,125=00	
67	Amrut Rechargeable battery sprayer of 16 litre capacity	25/2/2012	2	8,715=00	
68	Solar model 12 volts 20 watts	03/10/2012	1	2,842=00	
69	Mini multicrop thresher (5 Hp engine)	8/10/2012	1	47,475=00	
70	Strap drop and tank impact test rig	22/12/2012	1	99,700=00	
71	Hand operated vertical cylinder type bajra thresher	3/1/2013	10	38,000	
72	½ Hp electric motor operated vertical cylindrical type bajra thresher	3/1/2013	6	49,800=00	
73	Weighing scale	3/1/2013	1	981=00	
74	Hp 251 colour laser jet printer	22/1/2013	1	24,012=00	
75	Sony HDR-XR 260 handy cam hard disk	22/1/2013	1	44,895	
76	Test rig for fatigue on compression sprayer	30/1/2013	1	88,003=00	
77	Bicycle (Atlas brand)	30/1/2013	1	4399=00	
78	Test rig for spray lance	14/2/2013	1	64,477=00	

9. Where the project is undertaken: Department of Farm Machinery and Power Engineering, College of Agricultural Engineering, UAS, P.B. No. 329, Raichur - 584104

10. Places to visit to evaluate the project: College of Agricultural Engineering, UAS, P.B. No. 329, Raichur – 584104

11. Contact Person: Dr. M. Veerangouda, Professor & Head, Dept. of FMPE, CAE, Raichur

EVALUATION TEAM MEMBERS

Sl. No.	Name	Designation
1	Dr. B. C. Suryanarayana	Principal Investigator
2	Dr. M. A. Shankar	Associate Investigator
3	Sri. Siddaraju	Associate Investigator
4	Dr. M. Ananthachar	Subject Matter Specialist

Dr.Suryanarayana, B.C. is a doctorate in Agriculture with specialization in Agronomy and is a Certified Associate of Indian Institute of Banking (CAIIB), Fellow of Indian Institute of Valuers. He worked in State Bank of India from the year 1981 to 2014 as a Technical Officer and retired as Asst. General Manager (Rural Development). He is a practicing consultant in the field of Agriculture, Horticulture, poultry, dairy, fisheries and plant tissue culture and covered cultivation. He has about 35 years of experience in the field and has prepared several project reports for financial institution, written books in vanilla cultivation, anthurium, medicinal and aromatic crops, minor irrigation, poultry and dairy farming. He has appraised more than 6,000 proposals in agriculture and related fields for funding by the Bank and has also been involved in many studies relating to development of Agriculture and allied activities. He has served as a General Manager in a bio-fertilizer, bio-pesticides and organic manures manufacturing company and is also a Technical Director in a company involved in manufacture of agricultural implements and equipment.

Dr. M. A. Shankar is a doctorate in Agriculture with specialization in Agronomy. He is former Director of Research, University of Agricultural Sciences, Bengaluru and presently the Executive Member of Institution of Agricultural Technologists, Bengaluru and Co-Chairman of Agribusiness Consultancy Subcommittee. He has implemented 51 research projects for the University funded by International organizations, Central and State governments, Private firms. He has guided 6 Ph. D. students and 15 M. Sc., (Agri) students. As Dean of College of Agriculture, Hassan, he has, with his administrative skills, streamlined accounting, financial, academic and administrative issues. He has been involved in review and evaluation of Technical Reports of 32 All India Co-ordinated Research Projects (AICRP) spread all over India. He has also evaluated 11 operational research projects for the technical feasibility and implementation. He has published 173 peer reviewed research papers. He has also penned 54 booklets and books for the University. He has vast experience in evaluation studies of projects.

Sri. Siddaraju is a Graduate in Agriculture with more than 35 experience in the field of Agriculture. He has served in the Karnataka State Department of Agriculture (KSDA) as Asst. Agricultural Officer in Farmers' Training and Education Centre, Soil Testing laboratory and as Subject Matter Specialist. He was Deputy Director of Agriculture (Commercial Crops) for 6 years, District Watershed Development Officer for 2 years. He has also been Joint Director of Agriculture (Inputs) for 5 years. He was involved in preparation of Annual Programme Planning booklets pertaining to Agricultural Inputs in Department of Agriculture. After retirement, he is serving as Chairman, Agriculture Consultancy Subcommittee, Institution of Agricultural Technologists, Bengaluru and has been actively involved in evaluation studies of projects.

Dr. M. Anantachar has a mechanical engineering degree from Karnataka University, Dharwad, a post graduate degree in Farm Power and Machinery from Tamilnadu Agricultural University and a Ph. D. in Mechanical Engineering Sciences from Vishveshwaraya Technological University, Belgaum. He is a Fellow of Institution of Engineers (India) and a life member of Indian Society of Agricultural Engineers. He has over 35 years' experience in teaching and research in Farm Machinery and Power. He has authored four books and published 23 research papers on Farm Power and Machinery is International and National research journals. He has also published 12 international papers, 42 national papers, 52 papers in other research journals and conducted/ participated in 72 national level seminars. He also has 98 popular articles and 37 teaching manuals/ extension bulletins and e-resources to his credit. He has been a Technical Committee member in Mechanization Scheme of Department of Agriculture, Govt of Karnataka from 2006 to 2017, Krishi Yantra Dhare Scheme in Raichur district, SMAM Meeting from 2013 to 2017, for establishment of RFMSC (Rural Farm Machinery Service Centres) in Karnataka during 2016-17 and a member for preparation of technical specification for Farm Machinery Tender document from 2008 to 2017. He was also Principal Investigator of Farm Implements and Machinery (Mechanization scheme of ICAR) project from 1996 to 2017.