Technical Bulletin

MECHANIZATION IN MAIZE

- A Move Towards Farm Profitability

PROFESSOR JAYASHANKAR TELANGANA STATE AGRICULTURAL UNIVERSITY

Maize Research Centre, ARI, Rajendranagar
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MECHANIZATION IN MAIZE

- Farmers prosperity

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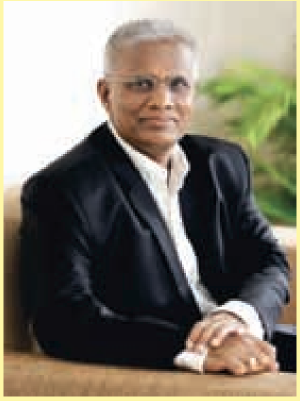

Dr. V. PRAVEEN RAO
Vice Chancellor

FOREWORD

Maize is the third most important crop after cotton and rice in Telangana State. Though the crop is grown round the year, it is mainly cultivated as rainfed crop in the state for which timely sowing is very crucial to make use of the available moisture in the soil. Farm mechanization has a big role to play in agricultural growth with efficient use of resources. Generally conventional practices are followed for most of the farm operations in maize viz., seed bed preparation, sowing, intercultivation, harvesting and threshing which consume lot of time, energy, cost as well as increase in drudgery to the growers. Due to high demand for labour in peak period of agricultural operations, delay in operations are resulting in poor crop yield and increased cost of cultivation. In fact, intensive maize-based cropping systems need timely harvesting for seeding of successive crop. Continuous rains during harvesting time maynot only damage the crop but delays the sowing of succeeding crop. In such a situation, mechanized harvesting may help the farmer to complete harvest in time.In view of its advantages, both Central and State governments are coming forward to support farmers through subsidies to purchase agricultural implements and machinery, thereby helping farmers to realize more net profits. In this context, the Maize Scientists of PJTSAU have demonstrated the advantages of selective mechanization through a Network project on “Mechanization in Maize” for wider publicity among farmers and brought out a technical bulletin **“Mechanization in Maize - A Move towards Farm Profitability”** to bring awareness in the farming community. This bulletin would also be very much useful to Agricultural Extension Officers, NGOs and Scientists who are in the field of Agriculture to motivate the maize farmers towards mechanized farm solutions.

(V. PRAVEEN RAO)

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Director of Research

PREFACE

Maize is the third most important crop after rice and wheat in India, engaging directly more than 12 million maize farmers and it is the third most important crop after cotton and rice in Telangana State, cultivated nearly in 14 lakh acres in both *kharif* and *rabi* seasons. It is grown on wide range of production environments ranging from temperate hill zones to semi-arid desert zones and grown in all three seasons in a year. Since, this crop is grown throughout the year at some or other stage of the crop growth period it suffers from non-availability of the labour because of higher labour demand of other two competitive crops like rice and cotton. This results in failure in implementation of timely operations leading to poor yields. In order to make agricultural production competitive and cost effective, the use of mechanical and electrical source of power have come to the rescue and the use of draught animals and human power is slowly being replaced by improved tools and implements suited to local conditions through use of tractors. The adoption of these improved implements play significant role in augmenting the yields by facilitating for quick operations in time and by relieving from the problem of labour shortage.

Since 80 per cent of the area is under rainfed in Telangana, the farm mechanization might play a big role in agricultural growth with efficient use of resources. In the light of its necessity, both Central and State governments are coming forward to support the farmers through subsidies on purchase of agricultural implements and machinery. In this context, the Maize Scientists have carried out a Network project on "Mechanization in Maize" and broughtout a technical bulletin **"Mechanization in Maize - A Move towards farm profitability"** with an intension to popularize the technology. I am sure, this technical bulletin is informative and useful to Agricultural Extension Officers, Scientists, Students and Farming Community to scale up mechanization.

(R. JAGADEESHWAR)

Mechanization in Maize

Background

- Maize (*Zea mays L*) is the third most important cereal crop in Telangana State. It is cultivated in a total area of 5.61 l ha, out of which 3.91 l ha, during *kharif* under rainfed and around 1.70 l ha, during *rabi* under irrigated conditions (2020-21).

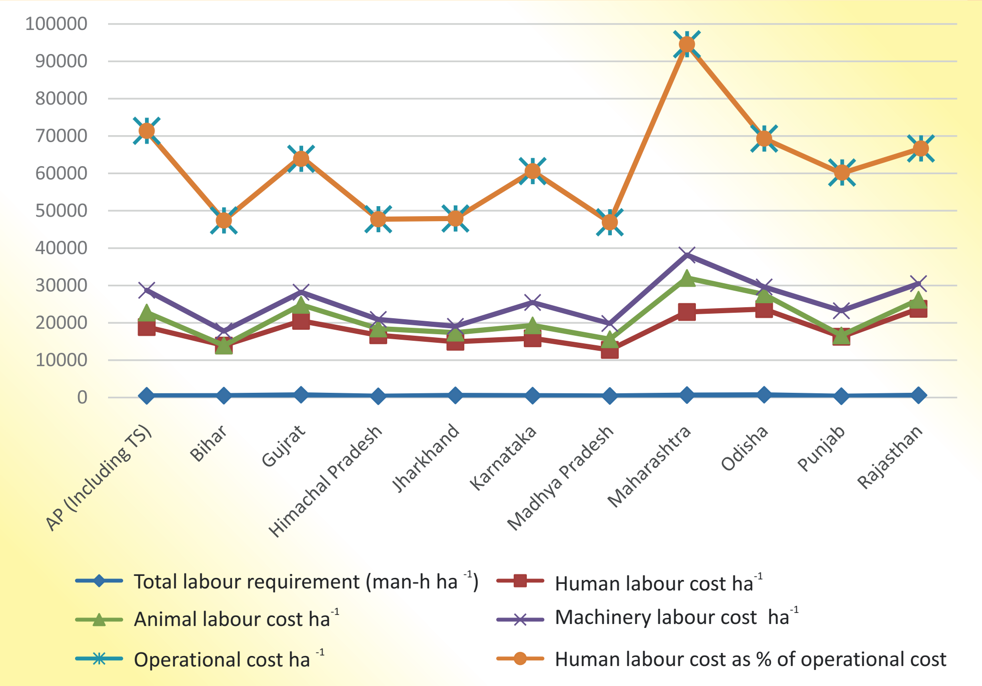
- Majority of the farmers in Telangana state are small or marginal and constitute 80% of total holdings where maize is cultivated mainly as rainfed crop and timely sowing is very crucial to make use of the available soil moisture in the soil.

- Conventional practices are generally followed for most of the farm operations in maize *viz.,* seed bed preparation, sowing, inter cultivation, harvesting and threshing which consume lot of time, energy, cost as well as increase drudgery to the growers.

- High demands for labour in peak period of agricultural operations resulting in delay in important operations like sowing, weeding and harvesting thereby reduction in crop yield. Further, the requirement of labour in different maize growing states ranges between 431 to 753 man-h ha^{-1} and 39-64 per cent of total operational cost is on labour component alone (Fig 1).

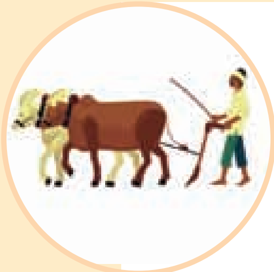
- Intensive maize-based cropping systems need timely sowing and also harvesting for seeding of successive crop. Continuous rains during harvesting time may damage the crop resulting in huge loss to the farmers. At such situation, mechanized harvesting may help the farmer to overcome the situation by quick harvest.

Fig 1: State wise cost incurred towards labour input in maize cultivation



(Source: Directorate of Economics and Statistics, 2015-16)

- The adoption of improved technology using modified implements play a significant role in augmenting the yields. Since 80% of the area is under rainfed in Telangana, the farm mechanization might play a big role in agricultural growth with efficient use of resources.

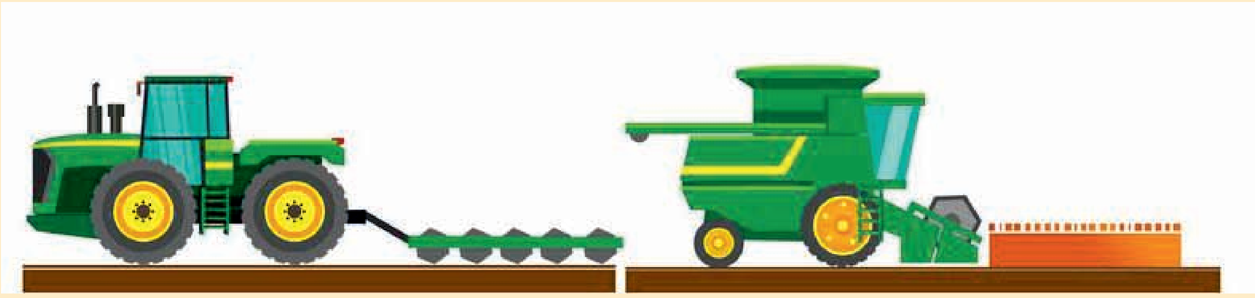


- In order to make agricultural production competitive and cost effective, the use of mechanical and electrical source of power has become necessity and the use of draught animals and human power is slowly being replaced by mechanization through use of tractors with various available improved tools and implements suited to local conditions.

- In view of its benefits, Central and State governments are supporting the farmers through subsidies to purchase of agricultural implements and machinery in order to facilitate them to switch over to the farm mechanization for realising higher productivity and reduced cost of cultivation and thereby making agriculture profitable to the farmers.

Level of Farm mechanization in India

- The level of farm mechanization in India is 40-45%, and is still lower than United States (95%), Western Europe (95%), Russia (80%), Brazil (75%) and China (57%) (Renpu, 2014).
- In India, Nothern States such as Punjab, Haryana, Western U.P have high level of mechanization (70-80%) due to high productivity levels and declining number of agricultural labourers. Whereas Eastern and Southern States have lower level of mechanization (35-45%) due to smaller and scatter land holdings. For, North Eastern states extremely lower due to hill topography, high transportation cost and socio-economic condition (Tiwari *et al.,* 2019).
- In crops such as maize the level of mechanization for different field operations *viz.,* seed bed preparation (90-95%), planting (80-90%), weed and pest control (70-80%), harvesting, shelling and threshing (50-60%) was reported (Mehta *et al.*, 2014).



Maize Scenario in World, Country and State

- Maize is the miracle crop grown in varied climatic conditions for food, fodder, feed and industrial purpose. Worldwide, maize is cultivated nearly 193.7 m ha area with a production of 1147.7m t and an average productivity of 5.75 t ha^{-1}(faostat.com, 2020).
- In India, it is being cultivated on 9.89 m ha with 31.69 m t production and an average productivity of 3.19 t ha^{-1} (indiastat.com, 2020).
- In Telangana State, it is cultivated in a total area of 5.61 l ha, out of which 3.91 l ha during *kharif* under rainfed and around 1.70 l ha during *rabi* under irrigated conditions with a total production of 29.97 l t and an average productivity of 5.34 t ha^{-1} (2020-21) (indiastat.com, 2021).

Among the cereals, maize is the most important resource-use efficient and high yielding crop extensively used in livestock sector as a feed and fodder. As maize has wide adaptability and compatibility under diverse soil and climatic conditions and hence it is cultivated in sequence with different crops under various agro-ecologies of the country and hence, it is considered as one of the potential drivers of crop diversification under different situation.The rapid adoption of high-yielding hybrid maize varieties in India has led to significant yield increases in the favorable rain-fed and irrigated maize growing area.The demand for maize is expected to grow in the years to come largely because of an increasing demand from the livestock and poultry feed industry as more animal protein is incorporated into the Indian diet. The rapid expansion of the biofuel industry in recent years and high fossil energy costs is also expected to have an impact on global maize demand and supply.

Mechanization Opportunities in Maize

- Cultivation of maize in wider rows permits the agricultural operations like sowing, weeding and harvesting operations with modern agricultural machinery thereby, successful implementation of seed to seed could possible in mechanization.
- Earlier, farmers were used to cultivate maize varieties/composites with different maturity periods wherein operation of advanced agricultural machinery such as harvesting machines was not feasible. However, after 2005, the development of single cross hybrids paved the way for mechanization due to their uniform seed, plant type and maturity. Now a days maize gained commercial crop status and spreading to larger areas due to its various industrial uses and attractive remuneration.
- Further, it is spreading to non-traditional areas wherein mechanization is already in practice in crops like rice, pulses and oil seeds *etc.* To increase farm profitability in such situations mechanized cultivation is the need of hour.
- Maize is predominantly grown as rainfed crop in the state where all the agricultural operations like tillage, sowing, weeding, earthing up *etc.,* are dependent on rainfall which provides little window period to perform all these operations. Hence, the mechanized cultivation will help in doing these critical operations in time and will reduce drudgery and enhance farm profitability of rainfed maize.

Options for mechanization in maize

- In order to make maize cultivation more profitable, seed to seed mechanization is the best option.The level of mechanization varies from place to place,cropping pattern and size of farming. There is immense potential to introduce mechanization in maize cultivation. Common options for mechanization in maize are detailed below:

Operations	Implements/machinery
Tillage and seed bed preparation	Mould Board and disc plough, cultivator, harrow, rotovator, levelers
Sowing/planting	Seed-cum-fertilizer drill, multi-crop vacuum planter, zero-till planter, happy seeder, ridge planter, broad bed planter
Fertilizer application	Seed-cum-fertilizer drill and fertilizer broadcaster, tractor operated fertilizer band placement cum earthing up machine
Weeding/intercultivation/ earthing up	Power weeder, Inter-cultivator, ridge maker
Irrigation	Drip irrigation
Plant protection	Boom sprayer
Harvesting and threshing	Combine harvester, maize dehusker cum sheller, maize dryer
Fodder harvesting/ Residue management	Shredder or rotovator

1. Tillage and land preparatory implements:

Tillage is the mechanical manipulation of soil, are performed to achieve the desired seedbed for proper seed germination and better plant growth. Seed bed preparation for sowing / planting of different crops is done through primary and secondary tillage operations.Primary tillage, cutting and turning of furrow slice is carried out to pulverize the seed bed. It also helps in burying weed seeds, insect pupae in deeper layers. In secondary tillage, disc harrow,cultivator etc., are used to crush the clods followed by smoothening and leveling of field.These operations help in good germination, crop stand and uniform maturity.

Mould board (MB) plough:

It is a primary tillage implement which is useful in preparing field up to 45cm, turned and pulverized the soil, cuts trashes and buries them inside the field. The implement can efficiently be used in stone free, non sticky soils. To avoid undulations in the field, two-way reversible mould board ploughs are available which can be operated with hydraulic shift lever. It works with 35 HP tractor and covers an area of 2.4-3.2 ha day^{-1}. The approximate cost of the implement is ₹ 42,000-48,000.

Disc plough:

It is also a primary tillage implement which is used in stony, hard and dry soils, where MB plough cannot be administered. This plough has got rolling plough bottom, hence it is useful for any type of soils up to a depth of 45cm. It works with 35 HP tractor and covers an area of 2.4-3.2 ha day^{-1}. The approximate cost of the implement is ₹ 42,000-48,000.

Tyne type Cultivator:

Cultivator is secondary tillage implement used for preparation of seed bed. It is also used for intercultural operation /weeding after adjusting tyne spacing. It covers an area of 2.4-3.2 ha day^{-1} and approximate cost of the implement is ₹ 30,000-32,000.

Disc Harrow:

The Disc harrow consists of rotating discs mounted on square centered shaft and with some disc, angle (20-230) to the line of travel. The rotation of discs will crush the clods and mixes with two opposite disc gang arrangements. The capacity of the implement depends on number of gangs and discs per gang. Normally it can cover 2.4-3.2 ha day^{-1}. The approximate cost is ₹ 42,000-48,000.

Rotovator:

Rotavator carries out secondary tillage operations such as harrowing and leveling in single operation. It destroys weeds, incorporates manures/fertilizers and left-over stubble of previous crop, brake down larger clods and pulverizes the soil. It prepares seed bed in one pass saving draft power, time, labour and cost as compared to conventional tillage. Rotavator can play an important role in intensively cultivated regions where window period for seed bed preparation is very narrow. Continuous use of rotavator may create subsoil compaction just beneath the operational depth, causing accumulations of water under excessive rain. It reduces land preparation cost by ₹ 1000-1500 per ha as compared to traditional method. It works with 35-45 HP tractor and covers an area of 2.0-2.4 ha day^{-1}. The approximate cost is ₹ 1,00,000-1,20,000.

Leveler:

Field with undulating topography suffers from uneven crop stand due to uneven seed placement depth and uneven distribution of moisture. Thus, land leveling is the pre-requisite for getting higher resource-use efficiency. Land leveling with tractor drawn leveler or laser land leveler provides precise land leveling and uniform moisture and crop stand.It works with 35-45 HP tractor and covers an area of 2.0-2.4 ha day^{-1}. The approximate cost of thee implement is ₹ 32,000-36,000.

2. Sowing/planting machines :

Manual method of seed planting, results in un-uniform spacing, low efficiency and drudgery to ache for the farmer. Mechanical sowing results in better seed placement and also maintains optimum plant population. Some commercially available maize seeding machines are discussed below.

Seed - cum fertilizer drill:

The seed - cum fertilizer is provided with seed and fertilizer boxes along with seed metering mechanism (trough feed) and mounted on 9 tyne cultivator (Rigid and spring tyned optional based on soil type). The depth control system was provided to maintain uniform depth through two guage wheels. The row spacing of the sowing can be adjusted as per the season/ requirement. The covering device is placed behind the implement to close the furrows immediately after sowing (with rear plank). Similarly, the same seed drill can be used for any type of seed sowing for which seed metering scoop wheels need to be changed. Fertilizer drilling qualities also can be monitored by changing sliding door at the bottom of fertilizer box and beginning of the fertilizer spout. It can plant 3.2-4.0 ha day^{-1} with 45 HP tractor. The approximate cost of the machine is ₹ 75,000.

Multi-Crop Vacuum Planter:

- The multi- crop vacuum planter provides high accuracy in seed spacing and the metering system allows single seed at a time even with uneven size and irregular shape of seeds. The soft rubber wheel reconsolidates soil without exerting much pressure on top of seed trench and helps prevent water stagnation on surface.
- Fertilizer distribution unit can easily set up and permits the delivery of a wide range of fertilizer rates. With the arrangement of mechanical row marker uniform row spacing will be maintained. The parallelogram mechanism helps to maintain level of planter as per contour of the ground with uniform seed depth. It covers an area of 3.2-4.0 ha day^{-1} and the approximate cost is The approximate cost is ₹ 6,25,000. Eventhough, the cost of the machine is high compared to seed drill the planter maintains required plant-to-plant distance, resulting in high yield and saving of costly seeds.

Ridge Planter:

Maize is very sensitive to water logging. Drought also causes substantial yield loss to the crop. Bed planting saves the crop in extreme water conditions like excess or deficit rainfall. During excess rainfall the furrow act as drainage channel while it stores rain water during low rain events. Ridge planters are commercially available which can do bed making and sowing on the tip of the bed in a single operation. Ridge planting ensure better root development, lesser lodging, saving of irrigation water and also cut down operational cost. It can plant 3.2 - 4.0 ha day^{-1} and approximate cost of the machine is ₹ 1,00,000-1,20,000

Zero- till planter:

Now a days Zero-till seed -cum ferti drill with furrow opener and seed metering system is available. It delivers both seed and fertilizer in different depths in the furrow. The inverted 'T' tyne opens the furrow with required depth, and hence, the moisture will not be evaporated. It works with 45 HP tractor and covers an area of 3.2-4.0 ha day^{-1} and approximate cost is the ₹ 75,000. Zero-till technology saves diesel, turnaround time and reduces land preparation cost and intercultural operations. It is a viable alternative to conventional tillage under which planting is done in stubble of previous crop without any soil disturbance so that increases soil organic matter. If zero planting is combined with residue mulching, it modifies hydro-thermal properties and protects the crop during adverse conditions.

Happy seeder:

Happy seeder consists of a straw management rotor for cutting the previous crop residues and a Zero- till drill for sowing of next crop. Flail type straight blades are mounted on the straw management rotor which cuts the standing stubbles/loose straw coming in front of the sowing tine and clean each tyne twice in one rotation of rotor for proper. The flails pushes the residues as surface mulch between the seeded rows. It covers an area of 2.4 -3.2 ha day^{-1}. The approximate cost is ₹1,00,000-1,20,000.

Wide Bed planter:

This planter is used for broad bed making and planting of maize simultaneously in single operation. It can prepare two raised bed per pass. Two row of maize is sown on tip of eachbed.It works with 45 HP tractor and make broad beds in an area of 2.4 -3.2 ha day^{-1}. The approximate cost of the machine is ₹ 1,35,000.

3. Fertilizer application Equipment

Top dressing of fertilizer in maize and other row crops is done by broadcasting method manually which results in low fertilizer use efficiency. Therefore, there is a need to mechanize the earthing up and top dressing of fertilizer application in maize which will result in saving of time, labour& fertilizer. Further, earthing up is an essential operation in maize crop which prevents the plant from lodging with better standability.

Tractor operated three row fertilizer band placement cum earthing up machine:

This machinecan perform three tasks in single operation, which are as follows:

- Placement of fertilizer (60 to 250 kg/ha) along the row (50 to 100 mm away from the plant),
- Earthing up (can cover 10 cm height of stem) and
- Cutting of weeds

This machine can save considerable amount of fertilizer, time and labour over traditional method. The field capacity of machine is 0.56 ha^{-1}. The approximate cost of the machine is ₹ 50,000.

Tractor Mounted Fertilizer Broadcaster

This equipment is used for uniform broadcasting of granular fertilizer at the time of basal application. The broadcaster mainly consists of a hopper and a spinning disc. The fertilizer from the hopper is made to fall on the spinning disc rotating at high speed, which in turn uniformly spreads the fertilizer.

4. Weeding/intercultural implements :

Maize due to its wider row spacing and slow growth initially may encourage severe weed growth and if maize crop is not kept weed free during the critical period (up to 3-4 weeks after sowing) cause yield reduction to the tune of 29 to 70 percent. Weeding operation is generally carried out with manually operated hand tool known as khurpi which is time consuming and requires considerable number of laborers. Due to labour scarcity during peak period, higher labour cost and drudgery, manual weeding is becoming lesser popular. Further during rains in *kharif* season manual weeding gets delayed considerably, contributing to considerable yield loss. Mechanical methods of weed control can complete the task in very short time, are viable alternative of the manual weeding. Mechanical weeding implements can destroy weeds by burying/ cutting/uprooting.

Tractor drawn inter-cultivator

Inter-cultivators are popular agricultural implements used for intercultural operations/weeding after adjusting tine spacing. This is a 4 row tractor operated inter-culture implement used for weeding. Its frame is provided with 4 tynes each tyne attached with T or V-shape sweeps to work in between 50-60 cm row spacing of the crop without any plant damage. Mechanical weed control using tractor mounted. Implements can only be done during the early crop stages because limited tractor and cultivator ground clearance damage the crop foliage at later growth stages. Working depth should be shallowto prevent plant roots damage. The approximate cost is ₹ 45, 000. Its field capacity is 3-4 ha day^{-1}.

Power weeder:

It is a diesel engine operated weeder with 50 cm operational width. It can cover 1-1.2 ha day^{-1} and approximate cost of the weeder is ₹ 48,000. The weeder is suitable for inter-culture operations and inter-rowweeding of maize having row spacing more than 45 cm. Its tynes can be adjusted to suit the row to row spacing of the crop and depth of operation.

5. Irrigation

Although, maize in the state is basically a rain-fed crop, in some ecologies, particularly during *rabi* season it is grown with irrigation. Flooding or furrow method of irrigation is more common for maize cultivation. These surface methods of irrigation need precise land leveling and water-guidance channel for uniform water distribution. These conventional irrigation methods are labor-intensive especially for irrigation channel construction, maintenance and operation. Such systems are also less efficient in water economy. Drip irrigation provides precise water application and does not need leveling, channel formation and channel maintenance. Further, simultaneous application of water and other inputs like fertilizer, insecticide and herbicide through drip lines are also possible which save labour and cost of application of agricultural inputs.

6. Plant protection:

Manually-operated knap-sack sprayer involves drudgery and needs more time to cover the field.

Use of mechanical sprayers ensures timely plant protection and efficient use of agro-chemicals.

Air assisted horizontal Sleeve Boom Sprayer

Boom sprayer can spray larger area with negligible time. It works well in wide space row crops having enough row to row spacing for mobility oftractor. Crop planting needs to be done in rows keeping in view track width of the tractor. The clearance provided in the boom sprayer mounting frame was not sufficient for crop more than 45 cm height so these sprayers are suitable for pre-emergence and early post emergence application of agro-chemicals. It can cover 1.12 - 1.25 ha h^{-1}. The approximate cost is ₹ 1,08,000.

7. Harvesting:

Timely harvesting of a crop is vital to achieve better quality and higher yield especially under bad weather conditions. The traditional practice of maize harvesting consists of stubble cutting with sickles followed by manual picking of mature cobs and requires 80-110 man ha^{-1}. This traditional method of harvesting is labour intensive, time consuming and also involves lot of drudgery. Mechanized harvesting using combine harvester reduces cost and ensure timely harvesting.

Self propelled Maize Combine Harvester:

It is used for direct harvesting and threshing of maize crop. It has specially designed cutter bar for maize. It has a gathering unit to guide the stalks into themachine and snapping rolls to remove the ears from the stalks. It can be used for harvesting othercereal crops in one operation by changing the header. It can harvest one ha in an hour. The approximate cost is ₹ 30.0 lakh.

8. Threshing/Shelling

Maize Dehusker Sheller:

Usually, the combine harvester will perform harvesting, shellingand separation of grains from ear/cob simultaneously. In case if the harvesters are not available, in such situations, after manual harvesting of the cobs along with husk and make use of dehusker cum sheller. This is dual-purpose machine is suitable for simultaneous removal of thecobs sheath along with separation of maize kernels from the cobs. It can save 95% shelling time and 60 % shelling cost as compared to traditional method. The shelling capacity is about 16-20 q day^{-1}. The approximate cost is ₹ 1,50,000.

9. Maize drying

At the time of harvesting, the grain moisture content is quite high (~30-35 %) and due to higher moisture content farmers cannot get good price of their produce. Beside this, storage at high grain moisture creates problems of fungal infection and can cause heating and loss of germination. Hence, after crop harvesting, drying of produce to bring at appropriate moisture level (12-14%) is very much essential. The approximate cost is ₹ 1,25,000/-.

Mobile Batch Dryer:

It is PTO or electricity driven, portable and long-lasting dryer. It can dry any type of grain and do not need pre-cleaning of grains. It is free of the risk of blockages or hot spots. Its drying rate ranges between 2-10 t h^{-1} depending on crop type, grain moisture content *etc.*

10. Fodder harvesting / Residue incorporation

Maize is considerably being used as fodder. Green fodder harvesting and further handling by harvesting traditional method is a labour-intensive operation. It needs nearly 40 man-days per ha for manual.

Now days, machines are commercially available which can perform three tasks in single operations *i.e.* harvesting, chopping and loading into trolley in a very cost-effective way.

Maize Shredder / Rotovator

In case of un-utilization of maize stover as dry fodder, it can be cut with shredder/rotovator implement and incorporate into soil which increases the soil organic matter and also for each ton of stover when incorporated into soil adds nutrients such as nitrogen equivalent to 65-70 kg urea, phosphorus equivalent to 16-20 kg SSP and potassium equivalent to 35-40 kg MOP and improves the soil fertility. The field capacity of the implement is 3-4 ha day^{-1} and the approximate cost is ₹ 80,000.

Implements and Machinery Suppliers Contact Details (Telangana State)

S. No	Equipment	Approx. cost (₹)	Contact Address
1.	Mould Board Plough (2 Bottom)	30,000/- to 35000/-	PrakashAgri Tools, Sri Chandra Mohan, LB Nagar, 9666039444 Tirumala tractors, Sri Mahinder, Tukkuguda, 9848337226
2.	Disc plough (2 bottom)	30,000/- to 37,000/-	
3.	Rotovator	80,000/- to 1,25,000/-	
4.	Disc harrow	42,000/- to 48,000/-	
5.	Rigid tyne cultivator (9-11)	30,000/- to 32,000/-	
6.	Tractor mounted boom sprayer	1,08,000/-	
7.	Honda Power weeder (Dry land)	48,000/-	
8.	Self-propelled Maize combine	24 to 30 lakhs	

Project Details

A net work project on maize mechanization was conducted by Maize Research Centre, Rajendranagar, Hyderabad and Agricultural Research Station, Karimnagar (in collaboration with DAATTC Centres, AICRP on FIM, AICRP on Weed control and State Department of Agriculture) during *Kharif*, 2018 and 2019 in three Agro Climatic Zones of Telangana (STZ, CTZ &NTZ) in farmer's fields as large size demonstrations using sowing and harvesting machines. The project locations are mapped in Fig 2. The list of villages and farmers are given in Annexure I.

Objectives:

- To study the feasibility of sowing and harvesting machines in maize
- To workout cost economics and comparative studies of conventional and mechanized cultivation
- Identification of operational problems in using machinery
- Popularization of mechanization in maize among the farming community

Fig 2. Project locations in Three Agro-Climatic Zones of Telangana State

Machinery Used

In the project the tractor drawn seed- cum- fertilizer drill, tractor operated multi-crop vacuum planter and W70 combine harvester were procured from M/s. Sarvodaya Mandali, and M/s Venkata Sai Enterprises, an authorized dealer of Johndeere Company respectively through custom hiring and the project was implemented during 2018 & 2019. The specifications of Seed-cum-fertilizer drill, Multi-crop vacuum planter and combine harvester were furnished here under.

Machinery	Specifications
Seed-cum-fertilizer drill 	• Power source (HP): 35-55 • Row to row spacing (cm): 45 to50 (Adjustable) • Seed to seed spacing (cm): 20 (Adjustable) • Depth of sowing: 4-6 • Weight of the machine (kg): 390 • Width of the machine (metre) 2.0 • Planting speed (km h^{-1}) 3.7 • Number of rows: 04 • Seed hopper capacity (kg): 70 • Fertilizer hopper capacity (kg): 70 • Fuel consumption (l h^{-1}): 3.0 • Cost of machine : ₹ 60,000/-
Multi–crop vacuum planter 	• Powersource (HP): 50 to 75 • Row to row spacing (cm): 45 to 85 (Adjustable) • Seed to seed spacing (cm): 3 to 45 (Adjustable) • Depth of sowing (cm): 4.0 • Weight of the machine (kg): 550 • Width of Machine (metre) 3.25 • Planting speed (km h^{-1}) 6 to 8 • Number of rows: 04 • Seed hopper capacity(kg):64 • Fertilizer hopper capacity (Kg): 200 • Fuel consumption(l h^{-1}) 4.0 • Cost of machine (lakhs):₹ 6.25
W70 Combine harvester (Johndeere) 	• Power Source (HP): 100 • Dimensions (LxWxH), (mm): 8190 x 4468 x 3400 • Number of rows: 06 • Cutter bar width (mm): 4267.2 • Fuel tank capacity (liters): 240 • Grain tank capacity (kg): 2700 • Threshing system: Rasp Bar and Spike Tooth • Machine weight (kg): 6900 • Fuel consumption(l h^{-1}) 7.0 • Cost of machine (lakhs): ₹ 30.0

Machinery Features

Sowing Machines

- The tractor drawn seed-cum-fertilizer drill is used for simultaneous activities of seeding and fertilizer application in a single operation. It comprises seperate hoppers for seed and fertilizer and drops them separately at different depths.

- The multi- crop vacuum planter provides high accuracy in seed spacing and the metering system allows single seed at a time even with uneven size and irregular shape of seeds.

- The soft rubber wheel reconsolidates soil without exerting much pressure on top of seed trench and helps prevent water stagnation on surface.

- Fertilizer distribution unit can easily set up and permits the delivery of a wide range of fertilizer rates. With the arrangement of mechanical row marker uniform row spacing will be maintained. The parallelogram mechanism helps to maintain level of planter as per contour of the ground with uniform seed depth.

Combine Harvester

- The W70 combine harvester is equipped with a reliable, fuel-efficient 74.6-kW (100-hp) John Deere 4039 engine which has good lugging power and less rpm drop even at peak load conditions.

- The harvester is having Posi-Torq mechanism in the lower unit which helps the harvester to work even in moist and undulating fields, offering easy maneuverability. The beater and beater grate is another unique feature of the W70 combine harvester. The beater has eight wings and rotates on an axis parallel to the axis of the normal rotor and concave. This increases threshing capacity significantly.

- The self-cleaning radiator enhances engine life by helping to prevent radiator choking. The suction duct releases chaff and other foreign material normally held on the surface of the screen by a suction mechanism. It reduces the manpower that was required to clean the radiator. The cutter bar can be adjusted to mid, extended, and retracted positions, enabling the combine to handle all crop conditions, which is especially important when there are lodged crops.

Methodology

Field preparation was done to obtain fine tilth suitable for sowing with planter by using tractor drawn mould board plough followed by disc harrow, cultivator and rotavator. The sowings were taken up from 27th June to 24th July in 40.0 ha soon after receipt of monsoon rains with multi-crop vacuum planter (John Deere). A public bred single cross maize hybrid DHM 121 was taken for demonstration. Required seed and fertilizers were filled in hoppers and sowing was taken up. An average of 0.4 ha h^{-1} was sown by using four row planter and the seed and fertilizer were placed at different depths (approximately between 4 and 4.5 cm) by following a row to row and plant to plant spacing of 55.6 cm x 22.0 cm with single seed per hill. After sowing, a pre-emergence herbicide, Atrazine @ 2.5 kg ha^{-1} was sprayed to control the weeds up to 25 days after sowing (DAS). Inter cultivation was done with tractor drawn inter cultivator at 30 DAS. The parameters recorded were seed requirement, spacing, depth of sowing (cm) and plant stand m^{-2} (No.of plants in sq.m at five random locations per acre).

Field demonstration of multi-crop vacuum planter

Based on the findings, it was observed that seed requirement per ha was the lowest in multi-crop vacuum planter (17.5 kg ha^{-1}) compared to seed cum- fertilizer drill (22.5 kg ha^{-1}) and conventional method behind the plough (25.0 kg ha^{-1}) , there is a saving of ₹ 1500/- per hectare in seed cost with multi-crop vacuum planter without compromising plant stand (Fig.3).The initial plant stand by using seed-cum ferti-drill was low (6.5 m^{-2}) as against the recommended plant stand of 8.3 m^{-2} while using multi-crop vacuum planter the plant stand was on par (8.2 m^{-2}) with recommended plant stand. But in conventional method where farmers were taken up sowing behind the plough, the plant stand was marginally lower than that of State recommendation (8.0 m^{-2}) (Fig. 4). The no. of plants per meter row length was lowest in seed- cum-fertilizer drill due to lack of precision in the machine unlike in multi-crop vacuum planter. The planter effectively metered out single seed per discharge at average planting depth of 4.0 cm with minimum percentage of seed damage. This is in conformity with Singh *et al.* (2007) who stated that, the pneumatic seed planter achieved precise seed distribution within the row as a result seed spacing was maintained due to its single seed metering mechanism unlike in conventional practice where higher seed rate and non-uniform plant population was observed which affect grain yield and profitability.

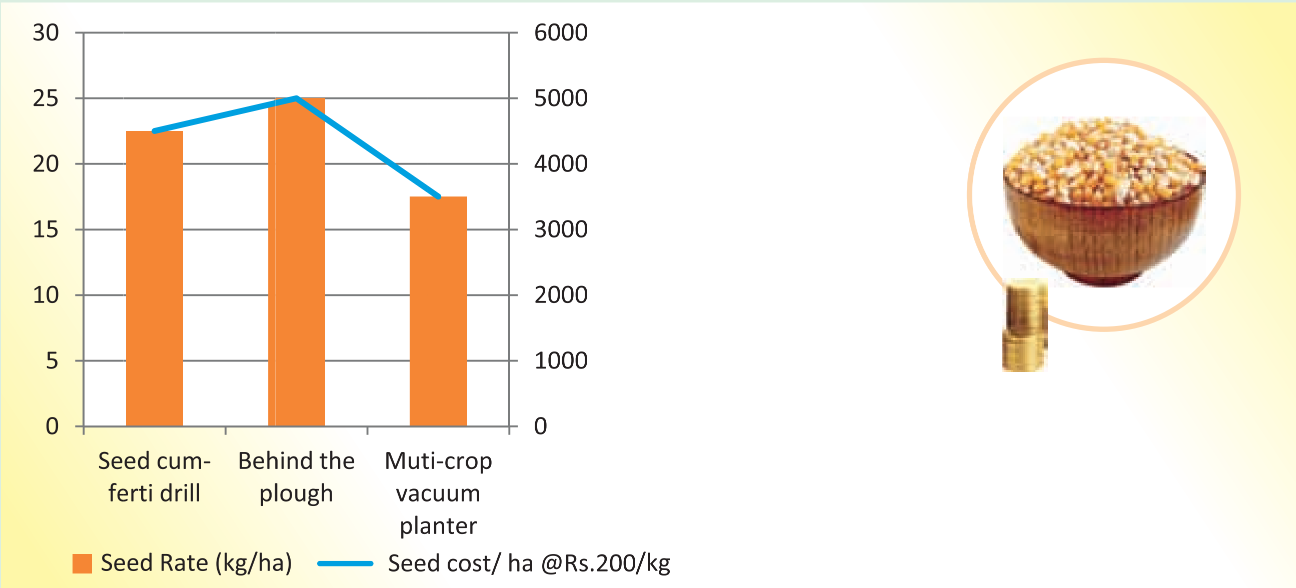


Fig 3. Seed rate and seed cost under mechanized vs conventional methods

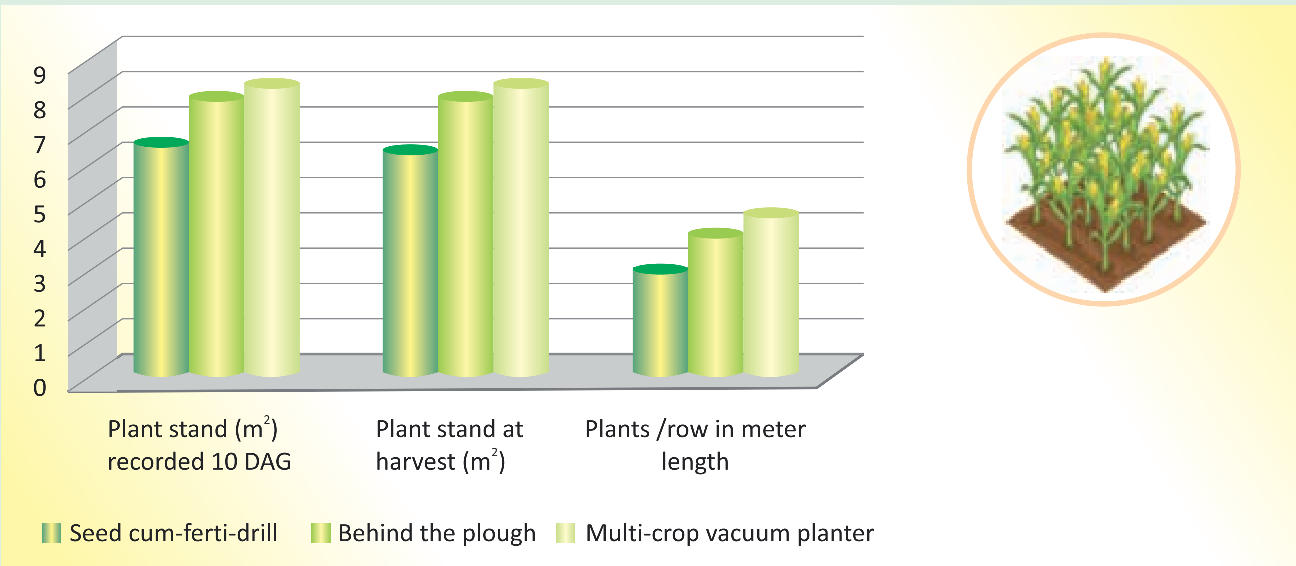


Fig 4: Plant stand (m^2) under mechanized vs conventional methods

Maize crop was harvested at physiological maturity (at 25% grain moisture) by using an advanced maize combine harvester. With this machine harvesting and shelling were done simultaneously and grains were collected in grain bin (2.7 t) where as in convention method manual harvesting and threshing with maize sheller was done. Later on the produce was cleaned by winnowing in both the methods and dried up to 15% grain moisture for long term storage.

Grain yields recorded were high in mechanized method (6916 kg ha^{-1}) over conventional method (6138 kg ha^{-1}) (Fig. 5). These studies are in conformity with Ajaib Singh (2014). The mean stubble height was recorded as 51.4 cm with combine harvester where as in conventional method it was recorded as 20.0 cm. Though the stubble height (cm) was high in mechanized method, it is not affecting the field preparations in ensuing season and the stubbles can easily be incorporated in the soil by using shrudder/ rotovator effectively (Fig.6)

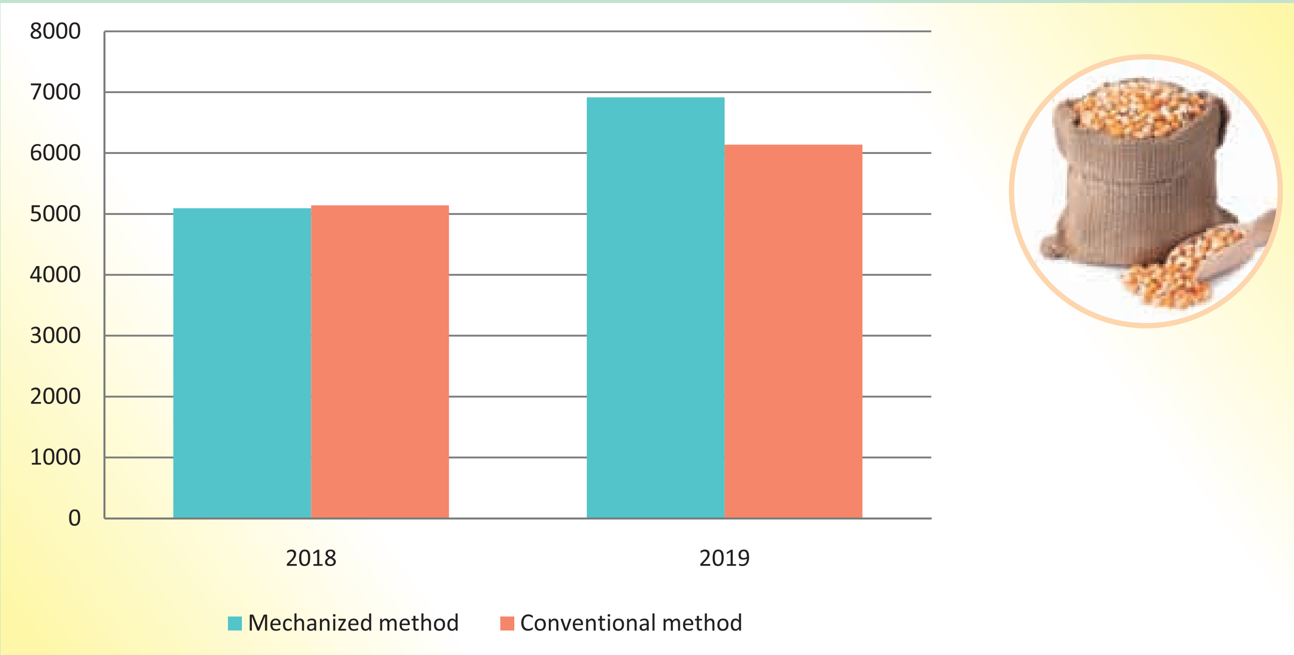


Fig 5: Grain yield (kg ha^{-1}) under mechanized vs conventional methods

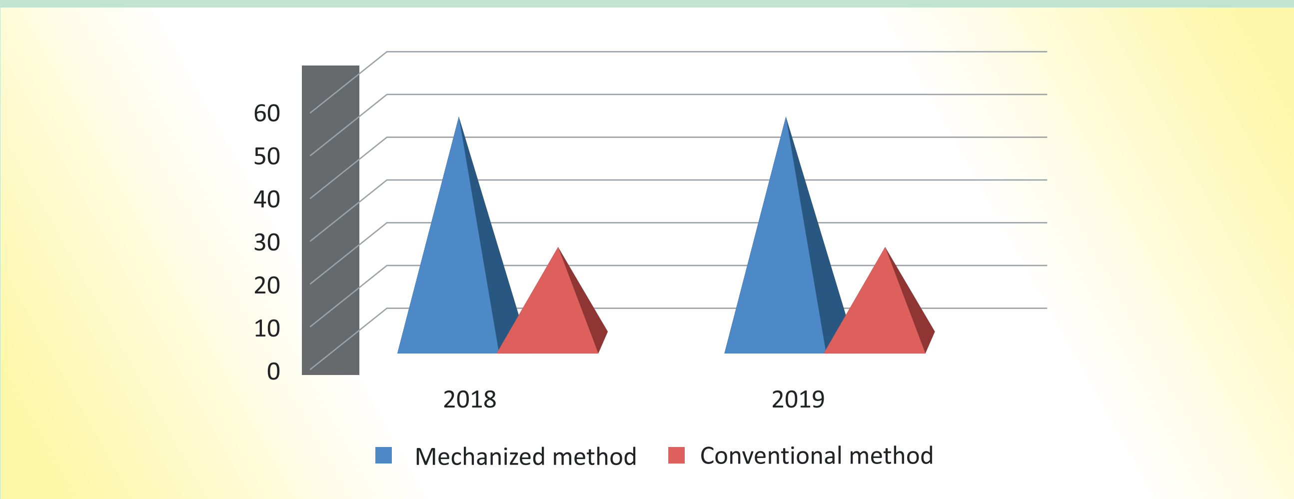


Fig 6: Stubble height (cm) after harvest under mechanized vs conventional methods

It was observed that more no. of broken grains was recorded in conventional method (8.0%) over mechanized method (4.0%) (Fig. 7 & 8). This might be due to high moisture content in grain at harvest (28%). But the impurities recorded were low in conventional method over in mechanical method.

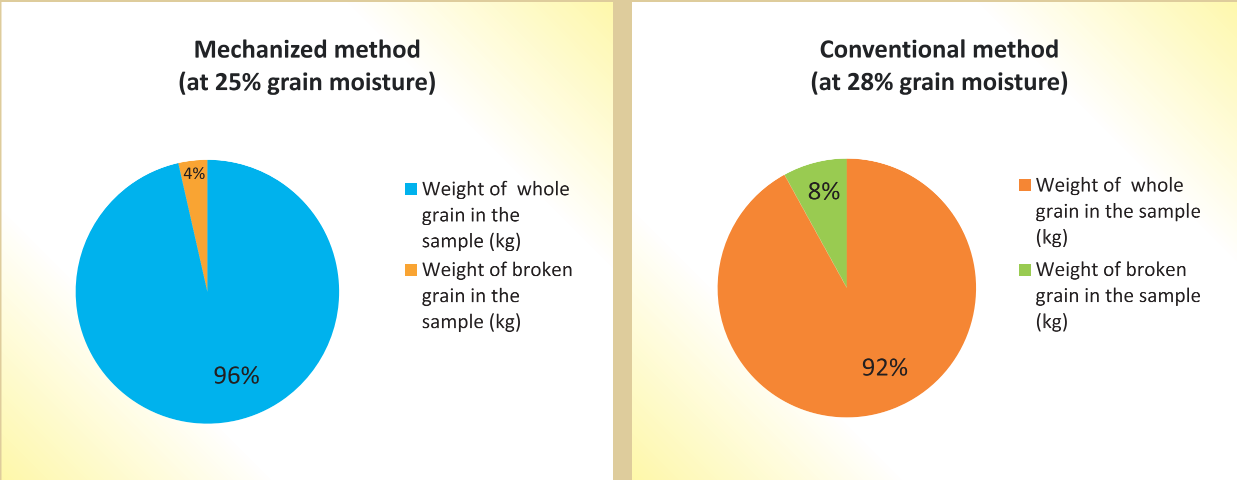


Fig 7: Weight of broken seed at harvest under mechanized vs conventional methods

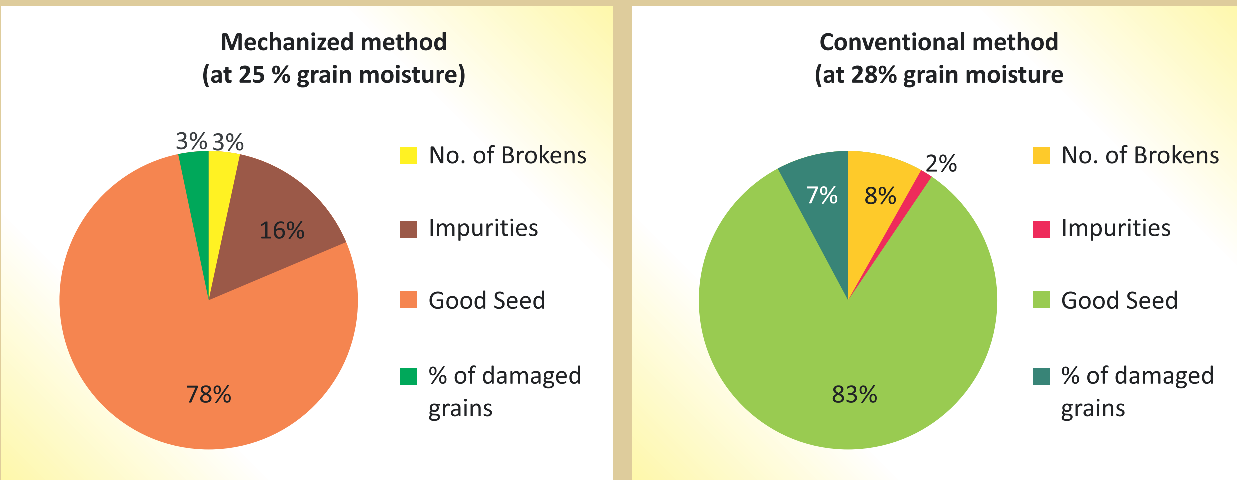


Fig 8: No. of broken seeds and impurities at harvest under mechanized vs conventional methods

A total of 672 man-h ha^{-1} were required to complete the operations from seed to seed in conventional method where as under mechanization it was 192 man-h ha^{-1}. Hence, there was saving of 480 man-h ha^{-1} in mechanized method (Table 1). Ajaib Singh (2014) also reported a saving of 100-140 man-h ha^{-1} with combine harvester over conventional method (manual harvesting followed by threshing with conventional maize thresher).

Table 1: Man days and expenditure particulars for mechanized vs. conventional method

S. No.	Particulars	Labour (man days)	Cost under conventional Method (₹)	Labour (man days)	Cost under mechanized method (₹)	Hiring of machinery/ ₹ ha^{-1}
1	Land preparation	--	7500	--	7500	
	Labour requirement					
2	Sowing behind the plough& fertilizer application (basal &top dressing) ₹300/head	8	2400	3	900	2500
	Hiring of tractor and plough		4000			
3	Spraying of Pre-emergence herbicide @ ₹ 400/head	5	2000	5	2000	
4	Thinning ₹300/head	5	1500	--	--	
5	Spraying of insecticide(2 times)@₹400/head	5	2000	5	2000	
7	Irrigation (Rainfed)					
8	Hand Weeding /inter cultivation/post emergence herbicide ₹ 300/head	25	7500	5	1500	
9	Harvesting & Shelling ₹ 300 head $^{-1}$	30	9000	2	600	7500
	Sheller rent ha^{-1}		2000		--	
10	Drying & stover cutting ₹ 300 head $^{-1}$	8	2400	4	1200	
	No. of man days ha^{-1}	**84**		**24**		
	No. of man h ha^{-1}	**672**		**192**		
	Total cost for labour (₹ ha^{-1})		**32800**		**8200**	
	Cost including land preparation (₹ ha^{-1})		**40300**		**25700**	
	Inputs					
	Seed (20 kg@₹ 180/kg)	--	3600		3150	
	Fertilizers					
	1) Urea (5/12 bags)	--	1400		3360	
	2) DAP (2.5 bags)	--	3400		3400	
	3)MOP(2.5 bags)	-	--		2100	
	Herbicide cost(₹400/kg)	--	1000		1000	
	Pesticide cost (Coragen @₹950/60 ml /Emamectin benzoate @₹650/80ml	--	4000		4000	
	Total input cost (₹ ha^{-1})		**13400**		**17010**	
	Total cost of cultivation (₹ ha^{-1})		**53700**		**42710**	

Note: Each day calculated @ 8 hrs day $^{-1}$ labour $^{-1}$

Field demonstration of combine harvester

Economics

The economic analysis of conventional and mechanized methods is shown in Table 1 & Fig. 9. The cost of seed to seed operations from sowing to final grain collection was highest in conventional method (₹ 53700 ha^{-1}) over mechanized method (₹ 42710 ha^{-1}). Though there is marginal saving in cost of cultivation in mechanized method, there are advantages like timely agricultural operations (sowing and harvesting in optimum time) and meeting the problem of labour scarcity at times of peak agricultural operations. The cost of cultivation for sowing in mechanized method was ₹ 6300 ha^{-1} and the time required for sowing one hectare was 2½ hours and with a saving of 5.5 man days ha^{-1}, where as in conventional method of sowing it was completed in 8 hours incurred a cost of cultivation of ₹ 11400 ha^{-1} (Table 2 & Fig. 10). Further, there is an additional advantage with mechanization as there is no labour requirement for thinning unlike in conventional method.

It was observed that the cost of cultivation for harvesting, shelling and drying along with removal of stover in mechanized method was ₹ 9000 ha^{-1} and time taken was 20 hours 15 minutes where as in conventional method, it was ₹ 13400 ha^{-1} and time taken was 82 hours. There was a saving ₹ 4400 ha^{-1} in mechanized method and time taken was also saved with a tune of more than 60 hours and 33 man days (Table 3 & Fig.10). These results are in conformity with Jagvir Dixit *et al.* (2010) wherein they reported that, tractor drawn maize planter could save 7-8 times the labour and 40-50% of the cost of operation over broadcasting method and also 20-25% higher yield was realized due to better germination and plant stand.

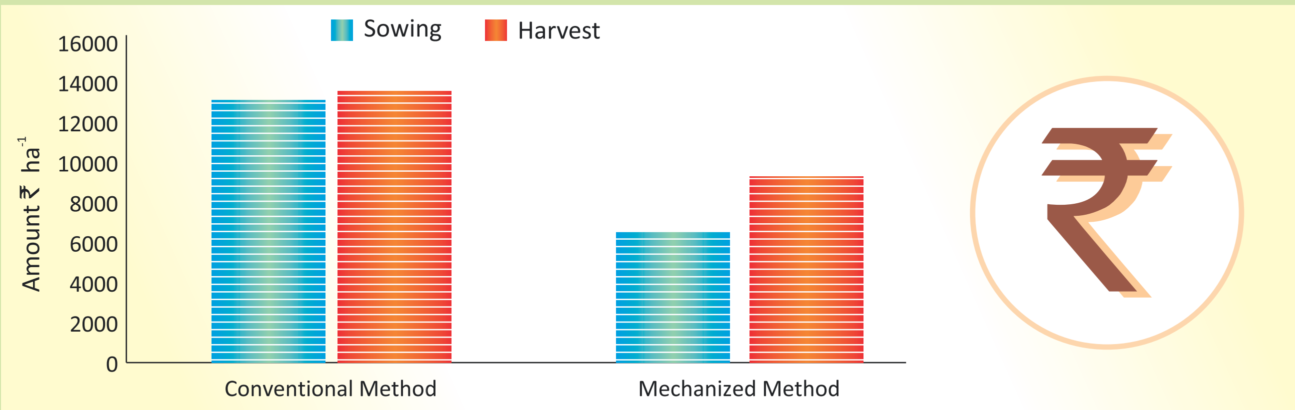


Fig 9: Cost of cultivation for sowing and harvesting under mechanized vs conventional methods

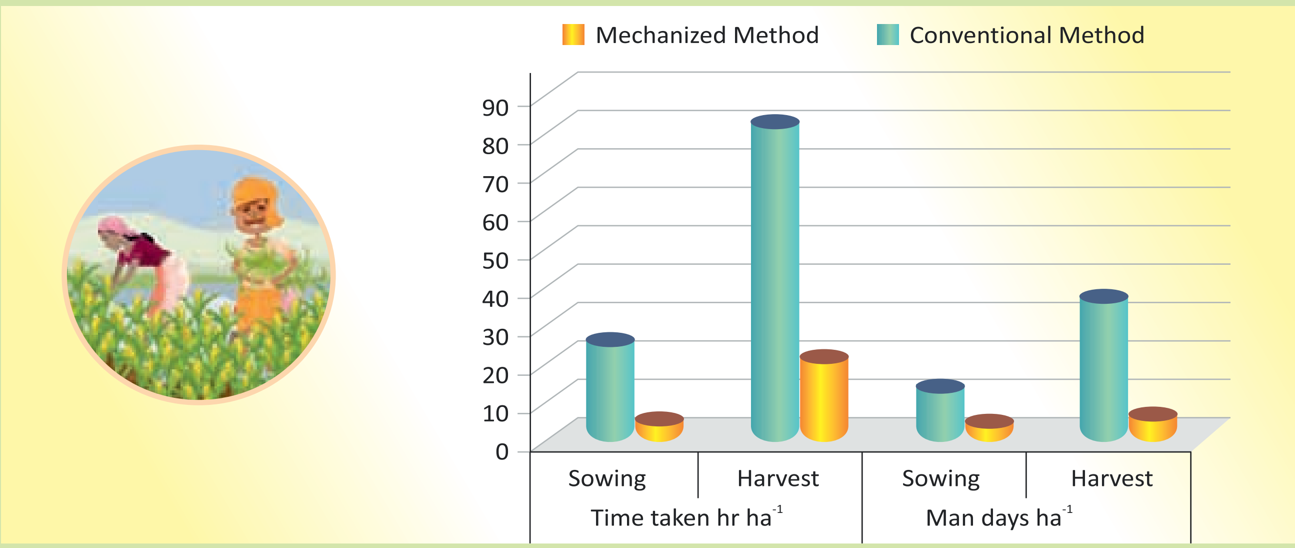


Fig 10: Time taken and man days required under mechanized vs conventional methods

Table 2: Cost comparison for sowing under conventional vs mechanized methods

Operation	Conventional Method				Mechanized Method			
	Time taken h ha^{-1}	Man days ha^{-1}	Rate ₹ $labour^{-1}$	Amount ha^{-1}	Time taken h ha^{-1}	Man days ha^{-1}	Rate ha^{-1}	Amount ha^{-1}
Sowing								
Hiring charges for sowing		-	4000	4000		-	2500 (hiring)	2500
Labour required for sowing and basal fertilizer application		8	300	2400		1	300	300
Seed required cost	8 hours	-	200 Rs/ kg	5000 (25 kg ha^{-1}	2.5 hours	-	200 ₹ kg^{-1}	3500 (17.5 kg ha^{-1}
TOTAL	**8 hours**	**8**	**-**	**11400**	**2.5 hours**	**2.5**	**-**	**6300**
Labour for Thinning	16 hours	5	300	1500	-	-	-	-
TOTAL	**24 hours**	**13**	**-**	**12900**	**2.5 hours**	**2.5**	**-**	**6300**

Table 3: Cost comparison for harvesting under conventional vs mechanized methods

Operation	Conventional Method				Mechanized Method			
	Time taken ha^{-1}	Man days ha^{-1}	Rate ₹ $labour^{-1}$	Amount ha^{-1}	Time taken ha^{-1}	Man days ha^{-1}	Rate ₹$labour^{-1}$	Amount ha^{-1}
Harvesting								
Harvesting of cobs	20 hours	10	300	3000	3 hrs 45 min	1	300	300
Dehusking of cobs	20 hours	12	300	3600			7500 (hiring)	7500
Shelling by Sheller	10 hours	-	2000 ha^{-1}	2000				
		8	300	2400				
Drying	16 hours	4	300	900	16 hours	4	300	1200
Stover cutting	16 hours	4	300	900	-	-	-	-
TOTAL	**82 hours**	**38**	**-**	**13400**	**20 hours 15 min**	**5**	**-**	**9000**

In terms of energy requirement, the total energy in maize production in conventional method was 15298.96 MJ ha^{-1} whereas in mechanized method was 22720.18 MJ ha^{-1} (Fig.11). The energy equivalent are calculated based on the factors mentioned in Table 4. Among all inputs, Nitrogen fertilizer used in maize production system had high share of energy requirement (Conventional method was 39.61 % where as in mechanized method was 58.22%). The energy required for Agricultural operations through human labour, diesel and machinery was comparatively low in mechanized cultivation (25.4%) to that of conventional method (39.78%). Further, the dependency on human labour was drastically reduced in mechanized method (1.65%) over conventional method (8.60%) saving with a tune of 6.95% (Table 5). Finally the energy output and input ratio was less in mechanized method (4.47%) compared to conventional method (5.89%) These results are in conformity with the report that maize cultivation accounted for 50.0% (1,772.2MJ ha^{-1}) of energy for land preparation. 25.6% (909.2 MJ ha^{-1}) energy is consumed for weeding and intercultural operation which is the second highest of energy consumption followed by 17.4% (615.6 MJ ha^{-1}) for sowing operation, harvesting and transportation consumed about 7.1% (250.3MJ ha^{-1}) of the total energy input (Yadav *et al.* 2013).

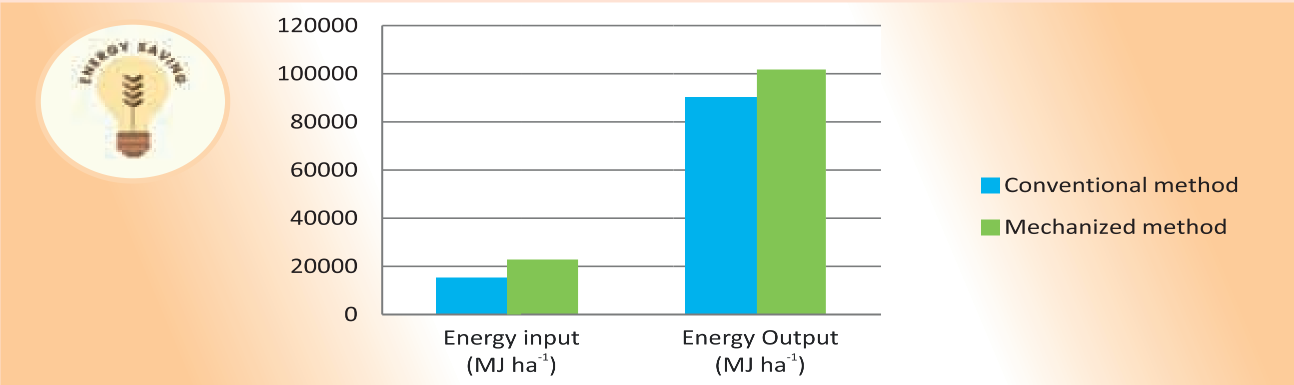


Fig 11: Energy requirement (MJ ha^{-1}) under mechanized vs conventional methods

Table 4: Energy equivalent of inputs and outputs in agricultural production

	Inputs	Unit	Energy equivalent (MJ/Unit)	Reference
1	Labour	h	1.96	(Yilmaz *et at.*, 2005; Singh & Mittal, 1992)
2	Machinery	h	62.7	(Erdal *et al.*, 2007, Singh *et al.*, 2002; Singh, 2002)
3	Tractor	h	68.40	(Singh & Mittal, 1992)
4	Diesel	l	56.31	(Erdal *et al.*, 2007; Singh *et al.*, 2002)
5	Fertilizers			
	Nitrogen	kg	60.6	(Shanhan *et al.*, 2008; Esengun *et al.*, 2007)
	Phosphorus	kg	11.1	(Shanhan *et al.*, 2008; Esengun *et al.*, 2007)
	Potassium	kg	6.7	(Shanhan *et al.*, 2008; Esengun *et al.*, 2007)
	Zinc	kg	8.40	(Pimentel, 1980; Argiro *et al.*, 2006)
6	Manure	kg	0.3	(Shanhan *et al.*, 2008; Demircan *et al.*, 2006)
7	Chemicals	kg	20.9	(Canakei *et al.*, 2005; Mandal *et al.*, 2002; Singh, 2002)
8	Water	m3	1.02	(Shahan *et al.*, 2008; Acaroglu and Aksoy, 2005)
9	Seeds	kg	14.7	(Singh & Mittal, 1992; Ozkan *et al.*, 2004)
	Outputs			
1	Grain	kg	14.7	(Singh & Mittal, 1992; Ozkan *et al.*, 2004)
2	Straw	kg	12.5	(Singh & Mittal, 1992; Ozkan *et al.*, 2004)

Table 5: Energy equivalents of input and output in maize production system

Equipments / inputs	Conventional method			
	Quantity per unit area(ha)	Energy equivalent (MJ)	Total energy equivalents (MJ ha^{-1})	Energy equivalents in percent
A. Inputs				
1. Human labour (h)	672	1.96	1317.12	8.60
2. Machinery (h)	8.75	62.7	548.63	3.58
3. Diesel fuel (L)	75	56.31	4223.25	27.60
4. Chemical fertilizer (kg)				
Nitrogen	100	60.6	6060.00	39.61
Phosphate	60	11.1	666.00	4.35
5. Pesticide (kg)	2.65	20.9	55.38	0.36
6. Seed (kg)	20	14.7	29.40	0.19
7. Water for irrigation (m3)	2352.14	1.02	2399.18	15.68
Total energy input (MJ)			15298.96	100
B. Output				
Maize grain (kg)	6138	14.7	90228.6	
Energy ratio(%)				5.89
	Mechanized method			
A. Inputs				
1. Human labour (h)	192	1.96	376.32	1.65
2. Machinery (h)	18.75	62.7	1175.62	5.17
3. Diesel fuel (L)	75	56.31	4223.25	18.58
4. Chemical fertilizer (kg)				
Nitrogen	200	60.6	13228.00	58.22
Phosphate	60	11.1	666.00	2.93
Potassium	50	6.7	335.00	1.47
5. Pesticide (kg)	2.85	20.9	59.56	0.26
6. Seed (kg) 17.5	14.7	257.25	1.13	
7. Water for irrigation (m3)	2352.14	1.02	2399.18	10.55
Total energy input (MJ)			22720.18	100
B. Output				
Maize grain(kg)	6916	14.7	101665.2	
Energy ratio (%)				4.47

Salient observations recorded during sowing and harvesting operations

Parameters observed	Seed-cum-fertilizer drill,	Multi-crop vacuum planter	Conventional method (Sowing behind the plough)
Sowing			
Row to row spacing	Maintained	Maintained	Maintained
plant to plant spacing	Precision is lacking in dropping of seed and 3-4 seeds were dropped per hill and some gaps were observed	Plant spacing is well maintained and single seed per hill was dropped	Irregular plant spacing and 3-4 seeds were dropped at a time causing some gaps
Depth of seed (5 cm)	Optimum seed depth	Optimum seed depth irrespective of soil condition	Sometimes seed placement was at deeper depth than required
Seed rate (20.0 kg ha^{-1})	22.5 kg ha^{-1}	17.5 kg ha^{-1}	25.0 kg ha^{-1}
Fertilizer placement	Both seed and fertilizers were dropped simultaneously	Both seed and fertilizers were dropped simultaneously in different furrows side by side	Only seed was dropped
Area covered	0.3 ha h^{-1}	0.4 ha h^{-1}	0.2 ha h^{-1}
Closing of open furrows after sowing	Simultaneously furrows were closed with blade harrow attachment soon after sowing. However closing of furrows not that much proper	Simultaneously furrows were closed with rubber wheel arrangement soon after sowing. Moisture was well maintained because of proper closing of furrows	Furrows were closed separately after sowing. Hence, there was gap of time as result chances of moisture loss
Harvesting			
Parameters observed	**Modified combine harvester**	**Maize combine harvester**	**Conventional method**
Time of harvesting(Harvesting and shelling)	4 to 5 h ha^{-1}	4 h ha^{-1}	50 h ha^{-1}
Cleanliness of the seed	Some husk comes along with seed and requires further cleaning	Some husk comes along with seed and requires further cleaning	Clean Final produce
Crop condition for	Machine will not	Machine will not	Manual harvesting
harvesting	harvest lodged plants/crop. Hence need to engage labour to collect the cobs	harvest lodged plants/crop. Hence need to engage labour to collect the cobs	

S.No.	Name of the farmer	Feed back	Remarks
1	Sri.Lakshmaiah	Sowing with Pneumatic planter is useful and the seed placement is appropriate with uniform row to row and plant to plant spacing	Expressed interest in going for mechanization in maize
2	Sri.Venkateswarulu	Expressed that sometimes the fertilizer movement choked due to clods in fertilizer while sowing with planter	Scientists advised to use dried and powdered form (no clods) fertilizers for easy flow.
3	Sri. Narayana Reddy	Expressed that the depth of sowing should be little bit deeper (> 5 cm) to avoid bird damage.	The technician of John Deer responded that the implement can be adjusted to a depth of 4-5 cm, if beyond depth of 5 cm the germination problem may occur.
4	Sri.P.Venkateswara Rao	Expressed many benefits viz., timely sowing, reduction in seed rate, proper placement of fertilizer and seed.	Expressed interest in going for mechanization in maize
5	Sri. Ponnam Raju	Satisfied with combine harvester for simultaneous operation of both harvesting and threshing of cobs without much broken grains and he requested to arrange on custom hiring basis, due to high cost of the machine	Expressed interest in going for mechanization in maize

The inference from the above results is that, mechanized method particularly sowing with multi-crop vacuum planter followed by W70 Combine harvester (M/s. John Deer Company) saved time with reduced drudgery of farm labour and cost of cultivation with higher maize grain yield per hectare. Under rainfed situation timely sowing helps to utilize available soil moisture resulting in uniform plant stand there by enhanced yields and reduction in cost of cultivation resulting in high net returns to the rainfed farmers.

Way Forward

Though there is advantage in mechanization in Agriculture, farmers may not be able to adopt the technology because of certain constraints in availability of machines on custom hiring in implementation of technology. These constraints can easily be addressed either by the State or Central Governments or both the Governments by offering subsidy on purchase of these machines. With this support, it is possible to increase Agricultural productivity, employment of rural youth and thereby increase in per capita income of the farmers

1. First and foremost step is to train rural youth in skill development on handling and maintenance of the agricultural machinery and implements.
2. Since the cost of machinery is high, Governments may come forward to provide subsidy on purchase of all Agricultural implements, machinery and other required tools to rural educated and trained youth to run Custom Hiring Centres so that youth gets employment and farmers get service at lower rates.
3. Initially to increase the area under mechanization subsidy may be provided on hiring charges of advanced farm machinery.

Literature

Ajaib Singh, 2014. Study of different methods of maize harvesting and threshing in Hoshiarpur district of Punjab. International Journal of Agricultural Engineering,7 (1): 267-270.

Faostat, 2020: http://faostat.com/

India Stat, 2020: indiaagristat.com; https://eands.dacnet.nic.in

India Stat, 2021: indiaagristat.com; https://eands.dacnet.nic.in;

JagvirDisit, Khan, J.N., Shukla M.M, 2010. Mechanization possibilities of maize cultivation in Hilly Regions of Jammu and Kashmir state of India. Agricultural mechanization in Asia, Africa and Latin America,41(3): 59-63.

Mehta, C.R., Chandel, N.S and Senthilkumar, T. 2014. Status,challenges and strategies for farm mechanization in India. Agricultural Mechanisation in Asia, Africa and Latin America, 45(4): 2014.

Tiwari, P.S., Singh, K.K., Sahni, R.K and Kumar, V. 2019. Farm mechanization-trends and policy for its promotion in India. Indian Journal of Agricultural Sciences, 89(10):1555-62.

Renpu, B.2014. Analysis of the trends of Agricultural mechanization development in China (2000-2020).ESCAP/CSAM Policy Brief,1:9.

Singh, H., Kushwaha, H.L. and Mishra. 2007. Development of seed drill for sowing on furrow slants to increase the productivity and sustainability of arid crops. Bio-systems Engineering, 98: 176-184.

Yadav, S.N., Ram Chandra, Tapan Khura and Narendra Singh Chauhan, 2013. Energy input-output-analysis and mechanization status for cultivation nof rice and maize crops in Sikkim. International Journal of Agricultural Engineering Vol. 15(3): 108-116.

Technology showcase at **Warangal**

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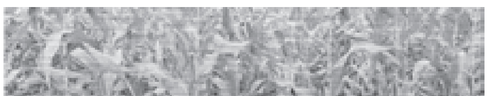
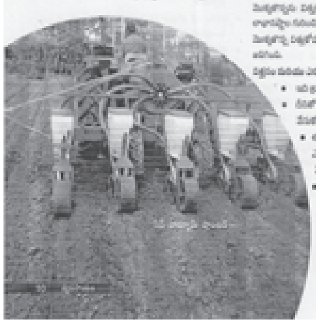
ఆంధ్రజ్యోతి

యంత్రాల వినియోగంతో మేలు

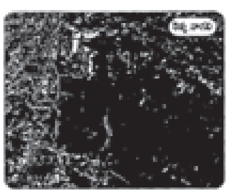
▸▸ వ్యవసాయ శాస్త్రవేత్త డాక్టర్ అనూరాధ ▸▸ మల్లన్నపూర్‌లో మొక్కజొన్న సాగుపై రైతులకు అవగాహన



మొక్కజొన్న సాగులో విత్తు యంత్రాలు



మొక్కజొన్న సాగులో యాంత్రీకరణ



ANNEXURE I

List of beneficiary farmers under mechanization of maize crop

Northern Telangana Zone			
S. No.	Name of the farmer	Village/Mandal/District	Extent of Area under mechanization (ha)
1	Sri. Agandle Ballaia	Mogilipalem, Thimmapur, KRM	1.0
2	Sri. Akula Boomaiah	Mogilipalem, Thimmapur, KRM	0.4
3	Sri. Agandla Srikanth	Mogilipalem, Thimmapur, KRM	0.6
4	Sri. Kariveda Narshima Reddy	Parlapelly, Thimmapur, KRM	0.6
5	Sri. Auvla Sadaiah	Parlapelly, Thimmapur, KRM	0.4
6	Sri. Antukala Sanjeva Reddy	Parlapelly, Thimmapur, KRM	0.8
7	Sri. Gummadi Sridhar	Mogilipalem, Thimmapur, KRM	0.4
8	Sri. Morepelly Raja Reddy	Mogilipalem, Thimmapur, KRM	0.8
9	Sri. Morepelly Malla Reddy	Mogilipalem, Thimmapur, KRM	1.0
10	Sri. Morepelly Kondal Reddy	Mogilipalem, Thimmapur, KRM	0.8
11	Sri. Gurram Srikanth	Mogilipalem, Thimmapur, RM	1.0
12	Sri. Thatla Thirupathi	Mogilipalem , Thimmapur, KRM	0.4
13	Sri. Gurram Kamala	Mogilipalem, Thimmapur, KRM	0.4
14	Sri. S. Komraiah	Mogilipalem, Thimmapur, KRM	0.4
15	Sri. Pashum Sudhaker Reddy	Mogilipalem, Thimmapur, KRM	1.0
16	Sri. Muppdi Sampathi Reddy	Parlapelly, Thimmapur, KRM	0.4
17	Sri. Marri Laxmi	Mogilipalem, Thimmapur, KRM	1.5
18	Sri. Morepelly Malla Reddy	Mogilipalem, Thimmapur, KRM	0.4
19	Sri. Saila Komariah	Mogilipalem, Thimmapur, KRM	0.8
20	Sri. Davu Sudhakar	Rekonda, Thimmapur, KRM	0.8
21	Sri. Nakka Chinna Rajaiah	Rekonda, Thimmapur, KRM	0.8
22	Sri. Nakka Chinna Rajaiah	Rekonda, Thimmapur, KRM	0.6
23	Sri. M. Srinivasa Reddy	Mogilipalem, Thimmapur, KRM	1.0
24	Sri. R. Ravinder Reddy	Mogilipalem, Thimmapur, KRM	0.8
25	Sri. Edulla Sampathi	Mogilipalem, Thimmapur, KRM	0.6
26	Sri. Augndla Laxmi	Mogilipalem, Thimmapur, KRM	0.6
27	Sri. Elakapelles Kumar	Mogilipalem, Thimmapur, KRM	0.8
28	Sri. S.Sunelu	Mogilipalem, Thimmapur, KRM	0.8
29	Sri. Kumar	Mogilipalem, Thimmapur, KRM	1.0
30	Sri.G.RajeswaraReddy	Katnapalli, Choppadandi, KRM	0.4
31	Sri.G.Jaipal Reddy	Katnapalli, Choppadandi, KRM	0.4
32	Sri.P.Venkata Ramana Reddy	Dubbapalli, Choppadandi, KRM	1.0
33	Sri.N.Damodar Reddy	Katnapalli, Choppadandi, KRM	0.4
34	Sri.AnjiReddy	atnapalli, Choppadandi, KRM	0.8
35	Sri.Regula Venugopal	Katnapalli, Choppadandi, KRM	0.4

36	Sri.J.Lakshmaiah	Katnapalli, Choppadandi, KRM	0.4
37	Sri.T.Chanti	Katnapalli, Choppadandi, KRM	2.5
38	Sri.B.Kittaiah	Mallannapalli, Choppadandi, KRM	1.0
39	Sri..K.Ramulu	Madhapur, Ganneruvaram, KRM	2.0
40	Sri.K.Mahesh	Madhapur, Ganneruvaram, KRM	4.0
41	Sri.D.Satish	Balaiah palle, Ganneruvaram, KRM	1.0
42	Sri.K.Balaiah	Balaiah palle, Ganneruvaram, KRM	0.4
43	Sri.R.S.Gattaiah	Yaswada, Ganneruvaram, KRM	3.0
44	Akula.Santhosh	Gopalpur, Ganneruvaram, KRM	0.4
		TOTAL	**40.0**

SNo	Southern Telangana Zone		
	Name of the farmer	Village/Mandal/District	Extent of Area under mechanization (ha)
1	Sri. S.Rambabu	Pedashapur, Shamshabad, RR	2.8
2	Sri. S.Ramulu	Pedashapur, Shamshabad, RR	0.8
3	Sri. S.Mohan	Pedashapur, Shamshabad, RR	1.6
4	Sri. S.Laxman	Pedashapur, Shamshabad, RR	0.8
5	Sri. S.Vasu	Pedashapur, Shamshabad, RR	1.6
6	Sri. S.Babulal	Pedashapur, Shamshabad, RR	1.6
7	Sri. S.Devsing	Pedashapur, Shamshabad, RR	0.8
8	Sri. P.Roopla	Pedashapur, Shamshabad, RR	0.8
9	Sri. P.Heerya	Pedashapur, Shamshabad, RR	0.8
10	Sri. P. Surmya	Pedashapur, Shamshabad, RR	0.8
11	Sri. P.Nanu	Pedashapur, Shamshabad, RR	0.4
12	Sri. Md.Khan	Ghasmiyaguda, Shamshabad, RR	3.2
13	Sri. P.Pullaiah	Ghasmiyaguda, Shamshabad, RR	1.6
14	Sri. A.Srinivas	Burjugadda, Shamshabad, RR	0.8
15	Sri. B.Raju	Peddashapur, Shamshabad, RR	0.8
16	Sri. P.Gobbriya	Pedashapur, Shamshabad, RR	0.8
		TOTAL	**20.0**

SNo	Central Telangana Zone		
	Farmer's Name	Village/Mandal/District	Extent of Area (ha) under mechanization
1	Sri. M. Pratap Reddy	Gorrekunta, Geesugonda, WRGR	0.4
2	Sri. Sarangapani	Gorrekunta, Geesugonda WRGR	2.0
3	Sri. M.Chakrapani	Gorrekunta, Geesugonda WRGR	0.8
4	Sri. K. Raju	Gorrekunta Geesugonda WRGR	0.4
5	Sri. K. Sambaiah	Gorrekunta, Geesugonda WRGR	1.2
6	Sri. J. Babu	Gorrekunta, Geesugonda WRGR	1.6

7	Sri. G. Krishnam Raju	Gorrekunta, Geesugonda WRGR	0.4
8	Sri. J. Annadham	Gorrekunta, Geesugonda WRGR	2.2
9	Sri. J. Harikrishna	Gorrekunt,a Geesugonda WRGR	2.8
10	Sri. P. Lingam	Malkapur, Chillpur, JNG	0.4
11	Sri. P. Raju	Malkapur, Chillpur, JNG	0.8
12	Sri. K. Gattaiah	Malkapur, Chillpur, JNG	0.4
13	Sri. B. Chandramouli	Malkapur, Chillpur, JNG	0.4
14	Sri. Pentaboina Laxman	Malkapur, Chillpur, JNG	0.4
15	Sri. P. Venkateshwarlu	Malkapu,r Chillpur, JNG	2.3
16	Sri. P. Mahender	Malkapur, Chillpur, JNG	1.3
17	Sri. P. Buchi Reddy	Malkapur, Chillpur, JNG	0.9
18	Sri. P. Komuraiah	Malkapur,Chillpur, JNG	0.5
19	Sri. K. Reddy	Malkapur, Chillpur, JNG	0.9
20	Sri. P. Venkat Reddy	Malkapur, Chillpur, JNG	0.9
21	Sri. K. Beerappa	Malkapur, Chillpur, JNG	0.8
22	Sri. P.Santhosh Reddy	Malkapur, Chillpur, JNG	0.9
23	Sri. P. Venkat Reddy	Malkapur ,Chillpur, JNG	0.5
24	Sri. M. Rajashekar	Malkapur ,Chillpur, JNG	0.9
25	Sri. G. Kumaraswamy	Malkapur, Chillpur, JNG	1.2
26	Sri. Y.Ravinder Reddy	Malkapur, Chillpur, JNG	2.0
27	Sri. Y. Sampath Reddy	Malkapur, Chillpur, JNG	0.8
28	Sri. P.Palli Ranith Reddy	Malkapur, Chillpur, JNG	0.8
29	Sri. D. Raju	Malkapur, Chillpur, JNG	1.0
30	Sri. K.Chandrashekar Reddy	Malkapur, Chillpur, JNG	0.8
31	Sri. E. Nirangan Reddy	Malkapur, Chillpur, JNG	0.8
32	Sri. M. Shetti Venkateswarlu	Malkapur, Chillpur, JNG	1.6
33	Sri. U. Genesh	Kondapur, Chillpur, JNG	2.0
34	Sri. G. Ilaiah	Kondapur, Chillpur, JNG	0.5
35	Sri. S. Sudhakar	Kondapur, Chillpur, JNG	1.2
36	Sri. M. Uppalaiah	Rajavaram, Chillpur, JNG	0.4
37	Sri. M. Krishnamurty	Rajavaram, Chillpur, JNG	0.4
38	Sri. B. Gopal	Raipalli, Zahirabad, SGR	1.2
39	Sri. Golla Balwanthu	Raipalli, Zahirabad, SGR	0.4
40	Sri. A. Jairaj	Raipalli, Zahirabad, SGR	0.4
41	Sri. R. Ashok	Sutharipally, Ramayanpet, MDK	0.4
		TOTAL	**40.0**
		GRAND TOTAL	**100.0**

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