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Mechanization in Pigeon pea – Scope and Opportunities in India

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Abstract

Pigeon pea is the second most important pulse crop next to chickpea in India. It is grown widely under rainfed conditions across tropical and sub-tropical regions of the World. Declining work force, increasing labour and production cost in Agriculture are necessitating introduction of mechanization in every crop and pigeon pea is not an exception to this. Mechanization minimizes use of labour and envisages utilization of various user friendly tools and farm machinery either partially or completely to perform various agronomic operations starting from pre-sowing to post harvest operations. We have discussed in this article the scope and opportunities available for achieving complete mechanization in sole as well as intercropped pigeon pea in India.

1. Introduction

Pigeon pea is an important multipurpose pulse and food legume crop in Asia, Latin America, Eastern and Southern Africa (Kumar et al., 2018). It is also known as arhar dhal, red gram and tur in India and Guandul in Puerto Tico, Gungo peas in Jamaica, *congo pea* in Sub-Saharan Africa and *kadyos* in Western Visayas region of Philippines. It is a N fixing, deep rooted and drought resistant legume with ability to grow across wide ranging soil types and regrow after relieving drought stress. It is the first seed legume plant whose complete genome has been sequenced. It is cultivated in around 82 countries, but, India is the global leader with an area of 4.54 M ha and 3.83 MT of production (Anonymous, 2020-21), accounting for 90% of production. It is the major of source of protein (22-24%) which is relished by all as a part of their meal. Like any other crop, the pigeon pea production in India is threatened by scarcity and increasing cost of labour especially during peak agronomic operations. Hence, there is dire need to introduce and upscale agronomic package for complete mechanization in pigeon pea.

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2. Scope and Opportunities for Mechanization in Pigeon pea in India

Sl. No.	Operation	Conventional practices	Partial mechanization	Complete mechanization
1.	Land preparation			
	Deep tillage and primary tillage	Cattle drawn country plough	Tractor drawn MB plough/disc plough/ chisel plough	Tractor drawn MB plough/disc plough/ chisel plough
	Secondary tillage	Cattle drawn danthi, blade harrow/planks	Tractor drawn cultivators, harrows, levellers, rotavators	Tractor drawn cultivators, harrows, levellers, rotavators
2.	FYM application	Manual	Manual	Loading FYM into tractors with JCB followed by application with tractor operated spinners
3.	Sowing and fertilizer application (only basal dose is recommended)	Behind the plough/ cattle drawn seed drill	Behind the plough/ cattle drawn seed drill	Tractor drawn seed drill/seed cum ferti drill (Figure 1)/ CRIDA six row planter/Precision planter cum herbicide applicator (Figure 2) Inter row spacing varies from 90-180 cm
4.	Weed management	Intercultivation through cattle drawn blade and manual hand weeding aided by khurpi	Intercultivation through cattle drawn blade and manual hand weeding aided by khurpi	Intercultivation through tractor (mini or ≥45 HP) drawn cultivator/ twin blade/ rotavator upto 30-45 cm height crop (Figure 3) Intra row weeding with manual weed scraper (Figure 4) Power tiller (Figure 5)/power weeder/ Tractor operated high clearance cultivator in a fully grown crop (> 1.0 m height) (Figure 6)
5.	Moisture conservation	Intercultivation with cattle drawn blade to a shallow depth	Intercultivation with cattle drawn blade to a shallow depth	Tractor drawn intercultivation cum conservation furrow tiller
6.	Plant protection (herbicide, insecticide and fungicide spray)	Knapsack sprayer	Knapsack sprayer/ battery operated sprayer	Motorised power sprayer/tractor drawn boom sprayer/Drone for spraying pesticides except herbicides (Figure 7 and 8)
7.	Manging excess vegetative growth	Manual nipping	Manual nipping	Nipping top growth with brush cutter (Figure 9)
8.	Harvesting and threshing	Manual harvesting with sickles, heaping, sun drying and threshing by beating against hard surface	Manual harvesting with sickles, heaping, sun drying and threshing by beating against hard surface or Manual harvesting with sickles followed by mechanical threshing with paddy combiner	Running paddy combiner on the crop (Figure 10)

Table: Continue...

Sl. No.	Operation	Conventional practices	Partial mechanization	Complete mechanization
9.	Winnowing	Manual winnowing in the open environment during windy hours	Manual winnowing in the open environment during windy hours	Electric or diesel operated winnower (Figure 11)
10.	Residue management	Manual collection, heaping and burning	Manual collection, heaping and burning	In-situ incorporation using multi crop shredder/rotary mulcher/ slasher/ rotavator (Figure 12 and 13)
11.	Labour and time consumption	High	Medium	Low
12.	Yield loss	Moderate	Moderate	Moderate
13.	Yield improvement over conventional methods	-	-	10-15%
14.	Energy usage	Low	Medium	High
15.	Constraints	Unavailability and high cost of labour	Unavailability and high cost of labour	Unavailability of machinery

Figure 1: Sowing pigeon pea with seed cum ferti drill

Figure 2: Sowing pigeon pea with high precision plater cum herbicide applicator

Figure 3: Intercultivation with tractor drawn cultivator in early stages of pigeon pea

Figure 4: Weeding in intra row space using weed scraper

Figure 5: Intercultivation with power tiller at later stage of pigeon pea

Figure 6: Tractor operated high clearance cultivator

Figure 7: Spraying with motorized power sprayer

Figure 8: Spraying with tractor mounted boom sprayer

Figure 9: Nipping top growth with brush cutter in pigeon pea

Figure 10: Harvesting pigeon pea with paddy combiner

Figure 11: Winnowing fan

Figure 12: Rotary mulcher

Figure 13: Multi crop shredder

Figure 14: Extra early short duration crop of pigeon pea

3. Is it Possible for Mechanization in Intercropped Pigeon pea?

The pigeon pea crop is grown as either sole crop or intercrop. It is intercropped with millets (maize, jowar, bajra etc.,), oilseeds (castor, peanut, soybean etc.,), pulses (mungbean and urdbean) and fiber crops (cotton). Due to differential growth habits, spatial and temporal variations, mechanical intercultivation is possible only when intercropped with castor or cotton. In other cases, suitable power weeders may be used for this purpose. However, mechanical intercultivation can be done in pigeon pea after harvesting of short duration and fast growing crops grown as component crops. Further, mechanical harvesting is possible in intercropped pigeon pea as it is going to be harvested after harvesting of all other component crops.

4. Residue Management

Conventionally farmers have been either burning or using pigeon pea stalks for thatch purpose and hulls as cattle feed. However, in completely mechanized farms, half of the stalks are spread in the field during mechanical harvesting and rest of the portion remains standing in the field. Rotary mulcher or multi crop shredder or slasher can be used to chaff the stalks into small pieces. This ecologically friendly method helps to soil health through addition of organic matter (Ramanjaneyulu et al., 2021).

5. Impact of Mechanization on Seed Quality

Mechanical damage and brokens will be more when unsuitable cylinders and inappropriate speed at

improper seed moisture are used during harvesting. The damage may vary from breakage and cracks to internal physiological damage. It fetches less or no price in the market leading to negative returns. Besides, it also reduces germination and vigour of seed so that it can't be used for seed purpose again. Hence, one should be careful about mechanical harvesting of seed production pigeon pea.

6. Advantages of Complete Mechanization in Pigeon pea

➢ Non shattering habit of pigeon pea makes it amenable for mechanical harvesting with little modifications to existing combiners

➢ Timely completion of all agronomic operations in a short time which is very important in dry land Agriculture where sowing window is narrow

➢ Aids in uniform crop establishment and growth and overall drought mitigation in rainfed ecologies

➢ Reduction in operational cost due to reduced human labour use by 30-35%

➢ Saves time

➢ Decreased cost of production by Rs. 6,000-8,000 ha^{-1}

➢ Equal or more yield by 10-15%

➢ Higher net farm income by 30-35%

7. Constraints in Complete Mechanization in Pigeon pea

➢ High cost of machinery

➢ Incessant rains may hinder the progress of agronomic operations with machines, thus, they can't be completed in time

➢ Repairs and maintenance problems with machinery

➢ Lack of trained or skilled man-power in the villages

➢ Optimum or recommended plant to plant spacing and population can't be maintained

➢ Lack of cultivar specific information on speed and type of blades required for combine harvester to be used for harvesting and threshing of pigeon pea

➢ Lack of awareness among farmers about complete mechanization in pigeon pea

➢ Mechanization is difficult with traditional tall growing and bushy pigeon pea varieties

8. How to Overcome?

➢ Government should provide subsidy on all high cost machinery

➢ Customized availability of machinery to all pigeon pea growing farmers

➢ A progressive farmer or a group of small farmers may purchase high cost machinery and rent out to fellow farmers

➢ Partial mechanization with blending of traditional practices may be advocated in case of unfavourable climate and depending on the economic conditions

➢ Capacity building on operational maintenance of machinery

➢ Training few farmers or educated persons in the village regarding repairs and maintenance of machinery

➢ Popularize agronomic package for complete/partial mechanization through demonstrations and exposure visits

➢ Generate data on specifications required for combine harvester and also seed moisture content in pigeon pea. For eg. Kumar et al. (2019) recommended 26.61 m s^{-1} and 2.0 km h^{-1} as optimum peripheral velocity and forward speed of combine harvester for extra shot duration varieties of pigeon pea in Punjab. Further, according to Lohan et al. (2007), use of lower cylinder speed and high concave clearance in rasp bar and spike tooth threshing cylinders is advantageous due to less seed damage and higher germination.

➢ Photo and thermo-insensitive, determinate, short statured (1.0-1.5m) and extra early short duration varieties (E-SDV) of pigeon pea (100-120 days) like ICPL-88039 and UPAS-120) have to be introduced (Gupta, 1990; Kumar et al., 2018). These are of great promise especially in pigeon pea based intensive cropping system like pigeon pea-wheat in North India and pigeon pea-groundnut/castor/corn systems in South India.

9. Conclusion

There is an ample scope for complete mechanization in Pigeon pea in India. Further, as pigeon pea is mostly intercropped under rainfed conditions, suitable and cost effective machinery have to be designed especially for weed management. The location specific high yielding extra early short duration varieties which are highly suitable for mechanized cultivation of pigeon pea based cropping system need to be bred and popularized. Furthermore, custom hiring centers should be established, so that, needy farmers can utilize the same depending on their requirement.

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