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Economics of farm mechanisation in Pigeonpea cultivation in northern dry zone of Karnataka

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Abstract
This paper attempts to evaluate the impact of mechanisation in pigeon pea cultivation in northern dry zone of Karnataka. The study was based on primary data, obtained through personal interview method using well-structured and pre-tested schedules. The total sample size was 30. The data pertained to the year 2017-18. The budgeting technique and output decomposition model were used to evaluate the impact of mechanisation. Mechanisation has led to human labour saving to the tune of 39.33 man days and 20.00 pair days of bullock labour by using additional 25.18 hours of machine labour. The mechanised farms made a human labour cost saving by Rs. 7881.87. The mechanised farms used slightly fewer quantities of inputs compared to non-mechanised farms. Yield was observed to be higher in mechanised farms (17.92 q/ha). The output decomposition model revealed that mechanised farms produced 35.37 per cent higher income in pigeon pea than that in non-mechanised farms. The mechanisation alone contributed 35.99 per cent increase in income, while fewer labour use of inputs depressed the income marginally.

Keywords: mechanisation, non-mechanisation and output decomposition analysis

Introduction
Indian agriculture is characterized by overwhelmingly small holdings due to higher population density and nearly two-thirds of its population residing in the rural areas coupled with unabated land fragmentation due to the inheritance laws of the country. Nearly 62 per cent of the estimated 142 m ha area is rain fed. The technological improvements in Indian agriculture since mid-sixties have brought about revolutionary increase in agricultural production. Interestingly, the growth rate of food grain production particularly in case of wheat and rice was much higher than the growth rate of population (Sing, 2006).

The country was facing acute food shortages till eighties and 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 for farm products. The increased use of purchased inputs in agriculture necessitated the increased use of human and bullock labour. But the rising wage rates and non-availability of farm labour made the case of farm mechanization stronger.

Over the years, the farmers are shifting towards cultivation of cash crops for a number of reasons including non-availability of farm labour. This has led to decrease in area under field crops. Thus, there is strong need for mechanization of agricultural operations. The factors that justify the strengthening of farm mechanization in the country can be numerous. The timeliness of operations has assumed greater significant in obtaining optimal yield, which has been possible by way of mechanization. The quality and precision of the operations are equally significant for realizing higher yields. The various operations such as land leveling, irrigation, 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

India is the largest producer, consumer and importer of pigeon pea in the world. In India, it is mainly grown in Maharashtra, Madhya Pradesh, Rajasthan, Uttar Pradesh, Andhra Pradesh and Karnataka. The projected pulse requirement for the year 2030 is 32 million tons with an anticipated required growth rate of 4.2 per cent as per IIPR Vision 2030 (Anonymous 2014). India has to produce not only enough pulses but also remain competitive to protect the indigenous pulse production. From mechanisation in pegion pea could help in enhancing the area under this crop.

With this backdrop, the current study was carried out in northern dry zone of Karnataka with the specific objective of analysing the profitability of Pigeon pea crop in mechanised and non-mechanised farms.

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Materials and Methods

The present study was conducted in northern dry zone of Karnataka. Among 35 taluks in northern dry zone, Sindagi taluk was selected in view highest concentration of agricultural equipments and the area under pigeon pea is also more in the zone. From Sindagi taluk three villages were selected namely Devarhipparagi, Bommanjogi and Kanolli and from each village 5 mechanised and 5 non-mechanised farms were randomly selected. Thus, the total sample size was 30. Mechanised farm is defined as the farm where the use of machines, whether mobile or immobile, small or large, run by power and used for tillage operations to harvesting and thrashing whereas non-mechanised is one where the use of human labour and bullock labour are used in cultivation of cops in agriculture, without using any machinery. The data pertained to the crop year 2017-18. The primary data on various aspects of labour use in production of pegionpea, use of mechanization and its impact on yield, income were obtained from respondents. For the purpose of achieving the objectives and to draw meaningful interpretations and inferences, the data were analyzed using the budgeting technique and output decomposition analysis.

For output decomposition analysis the following type of Cobb-Douglaus production function was defined.

$$Y = aX_1^{b1}X_2^{b2}e^u$$

Where, Y=Gross income in Rs/ha
X_1=Energy in joules/ha
X_2=Value of inputs in Rs/ha
u= Random error term

Using subscripts 'm and n' the production functions defining relationship between input and output were defined separately for mechanised (m) and non-mechanised (n) farms as follows

$$Y_m = a_m X_{1m}^{b1m} X_{2m}^{b2m} e^{um}$$
$$Y_n = a_n X_{1n}^{b1n} X_{2n}^{b2n} e^{un}$$

On log (Ln) transformation and algebraic manipulation of the above production functions, the following output decomposition model was obtained

$$(\ln Y_m - \ln Y_n) = (\ln a_m - \ln a_n) + \sum_{i=1}^{j}(b_{im} - b_{in}) \ln X_{in} + \sum_{i=1}^{j} b_{im}(\ln X_{im} - \ln X_{in})$$

The above decomposition equation was approximately a measure of percentage change in output/income with the adoption of mechanization. The first bracketed expression of the right hand side is the measure of percentage change in income due to shift in scale parameter (A) of the production function. The second bracketed expression is the difference between output elasticities each weighted by natural logarithms of the volume of that input used under non-mechanised farm, a measure of change in income due to shift in slope parameters (output elasticities) of the production function. The third bracketed expression is the sum of the natural logarithms of the ratio of each input of mechanised to non-mechanised farms, each weighted by the output elasticity of that input. This expression is a measure of change in output due to change in the per hectare quantities of input used.

Results and Discussion

1. Labour use and cost associated in mechanised and non-mechanised farms

The quantity of labour used in pigeonpea cultivation in northern dry zone is presented in Table 1. Total human labour utilization per hectare was more in non-mechanised farms, while mechanised farms have used more of machine labour (25.18 hours). The non-mechanised farmers also used bullock labour to perform various farm operations. It was observed that, the non-mechanised farms have used 39.33 man days more and 20.00 pair days of more bullock labour. Thus there was a substantial saving in the labour use in mechanised farms. Results were similar with findings of Khambalkar *et. al.,* (2010) [2] who reported that, there was decrease in cost of operation from Rs. 8407.50/ha in traditional method to Rs. 5147.00/ha in mechanised system in gram crop.

The expenditure of mechanised farms towards machine labour was Rs. 8594.92. Non-mechanised farms spent Rs. 15658.333 on human and bullock labour. Use of machines has reduced expenditure on human labour by Rs. 7881.87. The total labour expenses to perform various farm operations in pigeon pea on mechanised farms was Rs. 17648.05 while it was Rs. 32593.33 on non-mechanised farms. Thus there was a saving of about 50 per cent cost on labour in mechanised farms. This was due to use of machine labour in cultivating pigeon pea from sowing till harvesting which has been helpful in drastic reduction of human labour cost, while bullocks are employed for land preparation, inter cultivation and in some cases for transportation. Similar results were found in a study by Lavanya (2015) who reported that mechanisation reduced the use of human labour and net return per hectare were higher for tractorised farms than the non-tractorised farms.

2. Input use, cost and returns under mechanised and non-mechanised farms

Results indicated that there was more difference in average per hectare utilisation (Table 2) of human labour, bullock labour and machine labour between mechanised and non-mechanised farms. The mechanised farms used slightly fewer quantities of seeds, farmyard manure, chemical fertilisers and plant protection chemicals per ha than those used in non-mechanised farms. Yield was observed to be higher in mechanised farms (17.92 q/ha) compared to non-mechanised farms (11.75 q/ha). Use of chemical fertilizers and plant protection chemicals were more in non-mechanised farmers. Mechanised farmers have used machines like seed cum fertilizers for sowing and fertilizer application, combined harvesters for harvesting and threshing and hence there was a saving in labour use. The findings of the study were supported by research results of Mohapatra (2016) [4].

The two major components of the total cost incurred in cultivation of a hectare of pigeon pea were variable and fixed cost. Of the total cost, the expenditure on human labour accounted for higher share in the total variable cost. Total cost of cultivation was more in non-mechanised farms (Rs. 56857.56) compared to mechanised farms (Rs. 42259.15), while net returns per hectare of pigeon pea cultivation was higher in mechanised farms (Rs. 56482.52). The gross returns, total cost and net returns of the mechanised, partially mechanised and non-mechanised were tested for significant difference using t-test. The t-test analysis revealed that the gross returns, total cost and net returns was found significant at 1 per cent. Results found were similar with the findings of Santosh (2006) [7] and Mohapatra (2016) [4].

3. Decomposition of total change in per hectare income between mechanised and non-mechanised farms

Mechanised farms produced 35.37 per cent higher income in pigeon pea (Table 3) production than in non-mechanised farms. The change in income was further decomposed into different sources of change viz change in income due to mechanisation and due to change in inputs used. In mechanised farms, mechanisation alone contributed 35.99 per cent increase in income. The contribution of change in input levels was found to be negative (-0.62 %). It was interesting to note that the change in income due to mechanisation was non-neutral to scale implying that the benefits of mechanisation can be exploited fully by extending area under cultivation on a large scale. Result found was similar with the

findings Rudrapur (2015) [6].

Conclusion

It could be inferred from the results that, pigeon pea cultivation in study area was found to be more profitable under mechanisation. Mechanisation has led to human labour saving to the tune of 39.33 man days and 20.00 pair days of bullock labour. Use of machines in mechanised farmers has reduced human labour cost by Rs. 7881.87. Mechanised farmers produced 35.37 per cent higher income in pigeon pea production than in non-mechanised farmers. Hence the farmers need to be encouraged to adopt mechanisation in cultivation of selected crops to overcome the problem of scarcity of labour and to reduce the total cost of cultivation.

Table 1: Pattern of labour use and operation wise labour cost of pigeon pea cultivation (Per ha)

Sl. No.	Particulars	Mechanised (n=15)		Non-mechanised (n=15)		Difference	
I	**Human labour (Man days)**	Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)
1	Land preparation	4.23 (11.16)	1255.50 (12.86)	4.26 (5.52)	1083.33 (6.40)	-0.03	172.17
2	Sowing and intercultivation	20.70 (54.57)	4484.30 (49.53)	41.66 (53.93)	7751.67 (45.77)	-20.97	-3267.37
3	Manure & fertilizer application	9.60 (25.31)	2400.00 (26.51)	11.00 (14.24)	2750.00 (16.24)	-1.40	-350.00
4	Harvesting and threshing	3.40 (8.96)	913.33 (26.51)	20.33 (26.32)	5350.00 (31.59)	-16.93	-4436.67
	Total	37.93 (100.00)	9053.13 (100.00)	77.26 (100.00)	16935.00 (100.00)	-39.33	-7881.87
II	Machine labour (Hours)						
1	Land preparation	11.25 (44.67)	1901.25 (22.12)	0 (0.00)	0 (0.00)	11.25	1901.25
2	Sowing and inter cultivation	5.10 (20.25)	855.33 (9.95)	0 (0.00)	0 (0.00)	5.10	855.33
3	Manure & fertilizer transportation	4.25 (16.88)	1105.00 (12.86)	0 (0.00)	0 (0.00)	4.25	1105.00
4	Harvesting and threshing	4.58 (18.20)	4733.33 (55.07)	0 (0.00)	0 (0.00)	4.58	4733.33
	Total	25.18 (100.00)	8594.92 (100.00)	0 (0.00)	0 (0.00)	25.18	8594.92
III	Bullock labour (Pair days)						
1	Land preparation	0 (0.00)	0 (0.00)	4.66 (23.33)	3708.33 (23.68)	-4.67	-3708.33
2	Sowing and inter cultivation	0 (0.00)	0 (0.00)	7.83 (39.17)	6108.33 (39.01)	-7.83	-6108.33
3	Manure & fertilizer transportation	0 (0.00)	0 (0.00)	5.00 (25.00)	3000.00 (19.16)	-5.00	-3000.00
4	Threshing	0 (0.00)	0 (0.00)	2.50 (12.50)	2841.67 (18.15)	-2.50	-2841.67
	Total	0 (0.00)	0 (0.00)	20.00 (100.00)	15658.33 (100.00)	-20.00	-15658.33
	Total Labour Cost		17648.05		32593.33		-14945.28

Table 2: Input use, cost and returns in pigeon pea cultivation (Per ha)

Sl. No.	Particulars	Mechanised (n=15)		Non-mechanised (n=15)		Difference	
		Quantity	Value (Rs.)	Quantity	Value (Rs.)	Quantity	Value (Rs.)
A	**Variable Cost**						
1	Human labour (man days)	37.93	9053.13	77.26	16935.00	-39.33	-7881.87
2	Bullock labour (Pair days)	0.00	0.00	20.00	15658.33	-20.00	-15658.33
3	Machine labour (hours)	25.18	8594.92	0.00	0.00	25.18	8594.92
4	Seeds (Kgs)	13.50	818.62	17.50	1012.31	-4.00	-193.69
5	Farmyard manure (tones)	7.83	6029.67	8.33	7,125.00	-0.50	-1095.33
6	Chemical fertilizers (Qtls.)						
	a. Urea	1.58	968.94	2.08	1319.56	-0.50	-350.62
	b. DAP	0.91	2273.38	1.01	2445.33	-0.10	-171.95
	c. MOP	1.02	2389.60	1.11	2721.33	-0.09	-331.73
	Total	3.51	5631.92	4.31	6486.22	-0.80	-854.30
7	Plant protection chemicals (lit/Kgs)						
	a. Pesticide	1.63	688.50	2.29	801.67	-0.66	-113.17
8	Interest on working capital @7%		2157.37		3361.29		-1203.92
A	Total variable cost (Rs.)		32975.76 (78.03)		51380.95 (90.37)		-18405.19
B	Fixed Cost (Rs.)		9283.39 (21.97)		5476.61 (9.63)		3806.78
I (A+B)	Total Cost (Rs.)		42259.15 (100.00)		56857.56 (100.00)		-14598.41*
II	Returns (Rs.)						
	Gross Returns (Rs.)		98741.67		65445.83		33295.83*
II-I	Net Returns(Rs.)		56482.52		8588.27		47894.25*

Note: * and ** indicate significance at 1 % and 5 %

Table 4: Decomposition of total change in per hectare income between mechanised and non-mechanised farms (Per cent)

Sl. No.	Particulars	Pigeon pea
	Total change in measured income	35.37
1	Technology component	35.99
	a. Neutral component	-102.78
	b. Non-neutral component	138.78
2	Input contribution	-0.62

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