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RESEARCH PAPER

Performance Evaluation and Ergonomic Assessment of Pea Planter

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ABSTRACT

Garden pea is one of the most important vegetable cash crops of Himachal Pradesh which ranks among top ten states in pea production. Pea has enormous potential in domestic and export market. The state Government is also stressing for development of machines and tools for pea cultivation for small and medium level farmers in view of emerging labour problem. In hilly areas, most of the farmers are using traditional methods of pea sowing. So, keeping this in view, the present study was planned for adoptive trials of pea planter for mechanized intervention of pea sowing and to compare and assess the economic cost and the rate of drudgery involved. The planter had length of 95cm, width of 30cm and height 110cm. It included a 2.5 kg capacity seed box and had one vertical disc with 12 spoons on the plate for seeding mechanism. Two persons are required for operating the machine in push and pull mode. After 20 days of sowing, the germination percentage for planter was 93.8% and 98.6% in manual planting respectively. Total cardiac cost of work for pea planter was 595.83 and for traditional sowing was 867.88.

HIGHLIGHTS

- Garden pea is an important commercial vegetable crop of Himachal Pradesh.
- Replacing traditional pea sowing with manual pea planter can enhance the production by timely farm operations, reducing losses, as well as drudgery involved in farm operations.

Keywords: Pea planter, Himachal, Performance evaluation, Ergonomic assessment

Garden pea *(Pisum sativum)* is a cool season, frost-hardy, leguminous vegetable belonging to Family Fabaceae. It is grown in temperate regions at higher elevations or during cool seasons in warm regions throughout the world.

India is the second largest producer of pea after China and shares 21 percent production of the world. Major pea growing states in India are Uttar Pradesh, Madhya Pradesh, Punjab, Jharkhand, Himachal Pradesh, West Bengal, Chhattisgarh, Haryana, Uttarakhand and Manipur. On the global level, the area under garden pea is 2,266,000 hectare with a production of 17,430,000 metric tonnes (Anonymous 2014). In India, it is cultivated over an area of about 554 thousand ha with an annual production of 5524 thousand metric tonnes (Anonymous 2018).

Garden pea is one of the most important vegetable cash crops of Himachal Pradesh which ranks among top ten states in pea production. Pea farming occupies 27% of the total area under vegetable cultivation in the state with an area of 23.96 thousand ha and annual production of 291.04 thousand metric tonnes (Anonymous 2018). The main pea growing districts of the state are Lahaul and Spiti, Kinnaur, Shimla, Kullu and Mandi. With steady increase in acreage and production over the years, it has occupied the position of the most leading cash crop especially in the high (zone III

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and zone IV) and mid hills (zone II), from where the green pods are available during the period April to October and they find ready market in the plains bringing remunerative returns to the growers (Kumar and Chaudhary, 2014).

Pea has enormous potential in domestic and export market. It is used in fresh state as well as in processed form. In fresh state, mainly snow pea and sugar snap are exported due to their high demand in international market. Processed shelled peas are marketed in three forms: frozen, canned and dehydrated but more than 95% of shelled peas are used in frozen form.

Peas cultivation is highly labour-intensive like all other vegetable crops (Rao and Tripathi 1979). Mechanization in agriculture holds the key for sustainable development in the terms of increasing the production by timely farm operations, reducing losses, reducing the cost of operations by ensuring better management of costly inputs and enhancing the productivity of natural resources besides, it helps in reducing drudgery in farm operations. In hilly areas, most of the farmers are using traditional methods of pea sowing i.e. manual placement of seed with traditional tools, which consumes maximum time. Pea is a major cash crop of the state so, the Government is also stressing for development of machines and tools for pea cultivation for small and medium level farmers in view of emerging labour problem. So, this study was undertaken to assess acceptability, feasibility and ease of operation from users' point of view. Majority of the farmers do sowing operation using tools like khurpi etc. thereby adopting bending and squatting body postures due to which their physiological workload increases and they also face some types of musclo-skeletal problems as a result of which their efficiency decreases. By promoting appropriate machinery, the work and work environment can be improved, physiological workload can be reduced and efficiency/work output can be improved significantly. So, keeping this in view, the present study was planned for adoptive trials of pea planter for mechanized intervention of pea sowing and to compare and assess the economic cost and the rate of drudgery involved.

MATERIALS AND METHODS

The ergonomical evaluation of pea planter was conducted at university farm and the pea growing areas of *Kullu* and *Mandi* districts at the farmer's fields (n = 5 each) who are involved in pea farming on a commercial scale for years. An equal number of farmers were also selected for conventional method of pea sowing for working out the economics and drudgery rate.

The farmers were trained in operation of the planter before start of the actual experiment. The resting heart rate (HR_{rest}), oxygen consumption rate at rest (VO_{2rest}) and the blood pressure of the subjects were measured at rest and 15 minute prior to conducting the experiment. The blood pressure and heart rate of the subjects were measured by digital blood pressure monitor and polar heart rate monitor respectively. The oxygen consumption of subjects on their measured heart rate was estimated based on equation given by Singh *et al.* (2008).

$$Y = 0.0114\,X - 0.68$$

where, Y = oxygen consumption, l/min

X = heart rate, beats/min

The body mass index of subjects was calculated by dividing square of height (m^2) to weight (kg). During and after continuous pea sowing operation, working heart rate (HR_{work}) and recovery heart rate were measured. Based on these values, oxygen consumption rate at work (VO_{2work}), energy expenditure, total cardiac cost and physiological cost of work were worked out ((Singh *et al.* 2007). Based on the energy expenditure values, the categorization of the work was done as per classification by Nag *et al.* (1980).

Variable	Light	Moderate	Heavy	Extremely heavy
Energy cost (Kj/min.)	< 9.10	9.11-18.15	18.16-27.22	> 27.23

Overall discomfort rating for the activity was measured by VAD scale- a 10-point scale based on adoption of technique developed by Corlett and Bishop (1976). The category scale constructed by Borg (1982) was used to assess the rate of perceived exertion of workers after pea sowing activity.

RESULTS AND DISCUSSION

The specification of the pea planter is given in Table

1. The planter had length of 95cm, width of 30cm and height 110cm. It had one vertical disc with 12 spoons on the plate for seeding mechanism. The spoons had diameter of 10.5mm and 5.9 mm depth. It included a 2.5 kg capacity seed box and weighed 13.5kg. Two persons are required for operating the machine in push and pull mode and help of one person is needed for supplying/putting in the seeds.

Table 1: Specification of pea planter

Overall Dimensions, cm	
Length	95
Width	30
Height	110
No. of rows	1
Capacity of the seed box (kg)	2.5
Type of seeding mechanism	Vertical disc with spoons
No. of spoons on the plate	12
Spoons dimensions (mm)	
Diameter	10.5
Depth at centre	5.9
Type of power transmission	Through chain and sprocket from wheel
Type of furrow openers	Shovel type
Machine weight (kg)	13.5

The performance of the planter was assessed before carrying out the experiment (Table 2). Sowing of pea means the placement of seeds in soil at proper depth, with proper moisture and soil temperature. The pea variety used was PB-89 (Punjab-89) which is a popular variety in the state that gives a high yield of 60 q/acre. The plants of this variety are medium dwarf, vigorous, having more number of well filled pods (28-30 per plant). The pods borne in doubles and are dark green, long, very attractive having 9-10 grains per pod. It takes about 85-90 days for first picking. Shelled peas are very sweet and the shelling out turn is more than 55 per cent.

These seeds weighed 172 g for 1000 pea grains. Dimension of ten seeds was measured with help of vernier caliper that averaged out as 6.73, 5.48 and 5.58 mm for length, width and thickness respectively. Seed rate for the planter was calculated as 62 kg/ha while it is 90-100 kg/ha in conventional sowing. Depth of planting seeds with the planter was 2 cm deep. Plant to plant spacing came out as 10 cm while row to row spacing was fixed at gap of 45cm which is recommended for pea sowing. Total Field Capacity (TFC) was calculated as 0.081 ha/h whereas Effective Field Capacity (EFC) was 0.0535 ha/h. Field efficiency was worked out as 66 %. Cost of operation came out as ₹ 1401 /ha.

Table 2: Performance of pea planter

Particulars	Pea planter	Conventional sowing
Variety	PB-89	PB-89
1000 kernel weight (g)	172	167
Seed rate (kg/ha)	62	95
Size of seed (mm)		
Length	6.73	6.55
Width	5.48	5.56
Thickness	5.58	5.40
Depth of planting (cm)	2	3.5
Plant to plant spacing (cm)	10	7.5
Row to row spacing (cm)	45	25
TFC (ha/h)	0.081	
EFC (ha/h)	0.0535	
Field efficiency (%)	66	
Cost of operation (₹/ha)	1401	
Germination, %		
After 10 days	84.1	89.8
After 20 days	93.8	98.6

The average germination percentage after 10 days of sowing was 84.1% in comparison to about 89.8% in manual planting. After 20 days of sowing, the germination percentage for planter was 93.8% and 98.6% in manual planting respectively.

Before starting the experiment on ergonomic interventions in pea sowing, the subjects were made aware of the purpose and objectives of the study. They were also familiarised with the planter to remove their apprehensions regarding the machine. Age, height, weight and heart rate of each subject during rest were recorded. Mean height and weight of subjects were 169.25 and 159.5 cm and 62.5 and 56.2 kg respectively for pea planter and conventional sowing method which indicated a normal nutritional status. Heart rate of the subjects at rest was 90 and 82.6 with calculated oxygen consumption rate of 0.23 and 0.22 before conducting experiments by pea planter and by conventional method.

When both methods were compared ergonomically, it was observed that maximum heart rate during sowing by pea planter was 150.5 beats/min while

during conventional sowing it was 131.54 beats/min. Energy expenditure based on these values were calculated as 15.21 and 12.17 respectively. Oxygen consumption rate therefore came out as 1.04 and 0.82.

Table 3: Physiological parameters of subjects before pea sowing activity

	Pea planter		Conventional pea sowing	
Parameters	**Range**	**Mean**	**Range**	**Mean**
Age (years)	28-53	40.5	33-59	45.5
Height (cm)	164.3-173.4	169.25	152.3-163.4	159.5
Weight (kg)	53-70	62.5	40-68	56.5
BMI (kg/m^2)	17.76-22.49	21.86	17.24-25.09	21.94
HR_{rest} (beats/min)	70-103	90	66-90	82.6
Blood pressure (mmHg)	113/66-133/86	124.75/79.5	128/76-159/81	142.8/81
OCR_{rest} (l/min)	0.11-0.38	0.23	0.18-0.26	0.22
EE_{rest} (kj/min)	2.41-6.06	3.96	3.36-4.47	3.81

During the period of recovery, values of heart rate (recovery) were at par viz. 85.19 and 85.60 with subsequent oxygen consumption rate (recovery) of 0.29 and 0.30 calculated for subjects sowing pea by pea planter and traditional technique. Total cardiac cost of work for pea planter was 595.83 and for traditional sowing was 867.88 (Table 4).

Table 4: Mean physiological parameters of subjects during and after pea sowing activity

Parameters	**Pea planter**	**Conventional pea sowing**
HR_{avg} (beats/min)	133.89	111.54
HR_{max} (beats/min)	150.50	131.54
EE_{avg} (kj/min)	12.57	9.01
EE_{max} (kj/min)	15.21	12.17
OCR_{work} (l/min)	1.04	0.82
$HR_{recovery}$ (beats/min)	85.19	85.60
$OCR_{recovery}$ (l/min)	0.29	0.30
TCCW	595.83	867.88
PCW	0.016	0.025
Work categorization (EE_{max})	Moderate	Moderate
Overall discomfort rating	5 (moderate discomfort)	7 (heavy discomfort)
Perceived rate of exertion	3 (moderately heavy)	2 (heavy)

Muscular stress during the performance of the activity was measured by recording the incidences of discomfort and pain perceived by the subjects. The subjects were asked for their opinion about the operation of the sowing. The subjects perceived moderate discomfort and exertion in using the pea planter while they rated traditional sowing as heavy activity when compared with former. Traditional sowing required making of furrows and manual seed placing followed by levelling off the field as additional work. Majority of the farmers do sowing operations using conventional tools like khurpi (grub hoe), spade etc. thereby adopting bending and squatting body postures due to which their physiological workload increases and efficiency decreases. Based on the energy expenditure values (maximum) the categorization of the sowing work was 'moderate' for both techniques as per classification by Nag *et al.* (1980).

CONCLUSION

The farmers gave a very positive feedback for its performance as they used this planter for the first time and also evaluated it profitable in terms of reduction in sowing time and labour requirement as well. In Himachal Pradesh, *Kullu*, *Mandi* and Lahaul-Spiti are the main pea growing districts. In Kullu and Mandi area, the pea is sown in the months of October and November, and the crop is harvested nearly after two months. But in Lahaul-Spiti, due to climatic variations and harsh snowy winters, the pea crop is sown in the months of March to April and harvested as off season crop in the months of June- July. Lahaul- Spiti is a cold desert, therefore the soil here is a variable of sandy loam to silty loam that has loose and porous texture. Therefore, while conducting FLD at farmer's field, the front wheel and the seed tube of the planter were unstable on the top soil and digged into soil at an approximate depth of 12 cm and 4 cm respectively. So, the front wheel was replaced with light weight baby bicycle tyre that reduced the weight of planter and remained rotating on top soil. The farmers in the valley takes only one picking of fresh green pea pods after which the plant is then uprooted and dried for fodder purpose. Therefore, to get more number of plants and pea grains, the spoons were placed at a shorter distance of 5 cm to serve their basic purpose and to continue this traditional and popular cropping method in the valley.

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REFERENCES

Anonymous. 2014. Ministry of Agriculture, Govt. of India, 85 Institutional area, Sector 18, Gurgaon, India.

Anonymous, 2018. National Horticulture Board, New Delhi.

Borg, G.A. 1982. Psychological basis of physical exertions. *Medicine and Science in Sports,* **14**(5): 377-81.

Corlett, E.N. and Bishop, R.P. 1976. A technique for assessing postural discomfort. *Ergonomics*, (2): 175-82.

Kumar, A. and Choudhary, A.K. 2014. Scientific Cultivation of Vegetable Pea (*Pisum sativum* L.). pp 45-54. *In:* Choudhary, A.K., Rana, K.S., Dass, A., Srivastav, M. (Eds.). Advances in Vegetable Agronomy. [ISBN: 978-93-83168-17-0]. Post Graduate School, IARI, New Delhi & ICAR, New Delhi, India, pp. 358.

Nag, P.K., Sebastian, N.C. and Maulankar, M.G. 1980. Occupational workload of Indian agriculture workers. *Ergonomics*, **23**: 91-102.

Rao, N.S. and Tripathi, B.N. 1979. A study of economics of production and marketing of some vegetable crops in Kankipadu block of Krishna District, AP. *Allahabad Farmer,* **50**: 341.

Singh, S.P., Gite, L.P., Majumdar, J. and Agarwal, N. 2008. Aerobic Capacity of Indian Farm Women Using Sub-maximal Exercise Technique on Tread Mill. Agricultural Engineering International: the CIGRE journal. Manuscript MES 08 001. Vol. X.

Singh, S.P., Gite, L.P., Agarwal, N. and Majumdar, J. 2007. Women friendly improved farm tools and equipment. CIAE, Bhopal.