

P A R T - V

CHPATER - 1

3. A NEW ERGONOMIC 'FLOAT-SEAT' FOR IMPROVEMENT
OF PADDY CULTIVATION IN INDIA.

1. Introduction

When one considers common Indian agricultural workers' socio-economic status, land distribution pattern, and labour intensive operations, it becomes preferable to improve Indian paddy cultivation through betterment of existing methods and implement designs rather than by an input from capital intensive foreign mechanisation.

2. Review of earlier work:

Earlier studies on Indian cultivation are scattered and scanty. Rao ~~et~~ et al. (38), Ramana Murti and Belavady (39), Sen et al. (55) and ~~Nag~~, et al. (48, 57) determined energy expenditure in some agricultural workers. Studies on physiological responses in relation to work and thermal loads and rationalisation of work-rest cycle, gradation of heaviness of jobs were also undertaken by ~~sen~~ et al. (55) 83; 87; 209-213, 241, 266). The present investigation attempts to evaluate a new ergonomic seating arrangement for improvement of work posture (51, 55, 252-256) to Indian paddy cultivation. X

3. Aims and Objectives:

This investigation is to see whether the introduction of a new system of working in water logging agricultural field with a sitting posture boarding on an air inflated float seat be beneficial to the workers as well as increased productivity.

4. Materials and Methods:

4.1 Workers, Work and Work Place:

Fifteen highly experienced agricultural workers in the district of Midnapur, West Bengal, pulling out paddy seedlings (Fig.14) and transplanting them (Fig.15) in

the fields in the usual way were observed. Their physical characteristics were noted. The thermal data of the environment were obtained using sling psychrometer, Vernon's globe and Kata thermometers in the usual way (210).

4.2 Design of Float-seat:

Based on the preliminary studies, a new, low-cost, light-weight, air inflated rubber floating seat for the workers was designed and developed just like an air-inflated pillow.

4.3 Productivity and Physiological Responses:

Productivity and physiological responses such as pulse rate and oral temperature of the workers were determined in the existing conditions as well as while using, Fig.60, the newly designed float-seat.

4.4 Questionnaire Survey :

A questionnaire technique was used to assess pain at the different regions of the body and also to have workers' opinion on the newly designed float-seat.

5. Results and Discussion

5.1 Existing Methods of work :

Paddy cultivation in eastern part of India consists of some important manual operations : (1) to draw out the seedlings from the seed bed after suitable growth (about 15 cms in the case of high yielding varieties to about 77 cms in the case of common varieties) before the nodes or branchings appear at the stem, Fig.14, (ii) to transplant each bunch containing 4 to 8 seedlings with a gap between (15 x 15 cms in the case of high yielding varieties and 30 cms x 30 cms in the case of common varieties). These operations are undertaken by the workers in about



Fig. 68

Agricultural work using air inflated semi-float-seat.

calf-deep-water-logged muddy fields surrounded by raised earth boundary. The workers adopt mainly two types of working postures : (i) squatting posture kneeling down on one leg and keeping the other thigh pressed to the chest while drawing out seedlings one after another to form a bunch and proceed forward; (ii) standing with a bent back and legs apart, leaning forward, pressing with the left arm on the left thigh to rest and hand-full of seedlings, moving backward to transplant one after another a bunch of seedlings (Fig.15).

During these operations, pain at different body segments mainly on chest, thigh, neck and back muscles due to unergonomic working postures was noted. Normally, the workers take rest sitting on the raised earth boundary. Some time was spent in walking several times between the work place and the ridge. Sometimes boundary was unsuitable for taking rests. The existing method of work is not suitable for taking shorter work-rest cycle as suggested by Sen et al (209).

5.2 Physical Characteristics and Experiences of the workers :

The physical characteristics of the workers are given in Table-36.

5.3 Thermal Environment:

The thermal environmental data and the heat stress Index, the corrected effective temperature (basic), prevailing in the paddy fields during the study are presented in Table-37.

5.4 Work and Productivity Studies :

The results of work, time and productivity studies with and without the float-seat are presented in Table-38.

TABLE - 36
Physical Characteristics of the Agricultural Works (N=15)

Characteristics	Mean	± SD	Range
Age (yr)	30.2	8.69	22 - 50
Body Weight (kg)	51.89	3.29	46.5 - 60.0
Body height (cm)	162.73	5.08	156.0 - 172.7
Experience (yr)	13.6	9.36	5 - 32

TABLE - 37

Thermal Conditions During the Study.

Thermal Parameters	Mean	\pm SD	Range
Dry-bulb temperature ($^{\circ}$ C)	31.3	1.30	28.3 - 33.0
wet-bulb temperature ($^{\circ}$ C)	28.3	1.02	26.4 - 29.4
Relative humidity (%)	77.2	6.34	71.5 - 85.0
Globe Temperature ($^{\circ}$ C)	32.6	2.76	29.2 - 35.5
Air Speed (m/s)	0.98	0.80	0.20 - 2.28
Corrected effective Temperature (basic) ($^{\circ}$ C)	26.54	1.79	24.72 - 29.17

TABLE - 38

Time and Productivity Studies During Drawingout Seedlings and Transplanting Them, With and Without Using the Float-seat

Work-method	Drawing out seedlings (area worked - m ² /person/hour)	Transplanting (area worked m ² /person/hour)	% of total work hours seedlings and transplantation combined	Rest	Wastage
Existing method	4.33 ± 0.15	72.44 ± 1.52	65.63	29.50	4.87
(Without float-seat)	(4.12 - 4.48)	(70.22 - 74.45)			
New arrangement	4.98 ± 0.14	74.87 ± 1.45	72.50	27.50	0
(With float-seat)	(4.82 - 5.20)	(72.48 - 76.16)			

Mean ± SD; Figures in the parentheses indicate range. n = 15.

The working rate for drawing out seedlings was observed to be 4.33 ± 0.15 sq.meter land / worker / hour (average 32.48 sq.meter/worker/day) with the existing method and 4.96 ± 0.14 (average 37.35 sq.meter/worker/day) with the float-seat. The new arrangement is 14.99% more effective than the existing method of drawing out seedlings. The working rate in transplanting operation with the existing method was found to be 72.44 ± 1.52 sq.meter/worker/hour (average 543.30 sq.meter/worker/day) with the existing method and 74.87 ± 1.45 (average 561.33 sq.meter/worker/day) with the float-seat. The new system is thus 3.36% more effective than the existing transplanting method. In the existing method the average time of work is about 65.63 % and that of rest 34.37% including a wastage of 4.87% for walking to the boundary. The float seat arrangement saves the wastage, increases the working time to 72.50% as shown in Table 38. There is greater productivity due to lesser wastage of time and energy. Workers can take shorter work-rest pauses at the very work place sitting on the float-seat.

5.5 Questionnaire Survey :

The results from the questionnaire survey about opinions on the new float-seat are presented in Table-39. The new float-seat arrangement was found to be much more effective in drawing out seedlings and transplanting the high-yielding varieties (due to shorter transplantation gaps) than the common varieties of seedlings (larger transplantation gaps requiring greater backward speed).

The use of float-seat reduces the degree of pain at different body segments as compared to that with the existing method. It is supported by cent percent positive opinion, presented in Table-37. The 50% of the opinions favoured tying the float-seat on the hip and other

TABLE - 39

Workers' subjective assessment of pain at different regions of the body and preference of the new float-seat as compared to the existing method through a questionnaire technique

	Percentage of positive responses	
	Preferred	Not preferred
1. Relief of pain at chest and waist during drawingout seedlings	100	0
2. Relief of pain at neck and back during transplantation	100	0
3. Drawingout seedlings	100	0
4. Transplantation of high yielding varieties of seedlings	53.3	46.7
5. Transplantation of common varieties of seedlings	13.3	86.7
6. Float seat to be tied at hip	50	50

50% preferred to work on float-seat kept free.

5.6 Physiological Cost:

The physiological response of the workers are presented in Table-40. The working pulse rates were $125 \pm 7.84 \text{ min}^{-1}$ and $129.03 \pm 9.03 \text{ min}^{-1}$ respectively in existing drawing out seedlings and transplantation operations whereas oral temperatures were 37.38 ± 0.14 and 37.42 ± 0.31 respectively, grading these operations as moderately heavy, (Sen et al., 241). The working pulse rates, using float-seat, were $106.8 \pm 4.60 \text{ min}^{-1}$ and $103.0 \pm 4.33 \text{ min}^{-1}$ respectively in drawing out seedlings and transplanting operations whereas oral temperatures were 37.17 ± 0.57 , and $37.29 \pm 0.24^\circ\text{C}$ respectively. The working cardiac cost significantly decreased both in drawing out seedlings and transplanting operations with the use of new float-seat.

6. Conclusion

6.1 Benefits in the Use of Float-seat :

1. Ergonomic improvement of postures to work mostly sitting instead of an awkward bent and kneeling posture.
2. Facility to take shorter work-rest cycle throughout the working period.
3. Workers need not walk several times to use field boundaries as rest places. This saves time and energy.
4. Reduction of general fatigue and pain at different body segments.
5. Float-seat is of low-cost.

TABLE - 40

Physiological Responses of Agricultural Workers
With and Without Using Float-seat

Operations	At Work	
	Pulse Rate (beats/min)	Oral Temperature (°C)
Drawingout Seedlings		
Without float-seat	125.0 ± 7.84 (113.2 - 142.9)	37.38 ± 0.14 (37.20 - 37.60)
With float-seat	106.8 ± 4.60 (100.0 - 115.4)	37.17 ± 0.57 (36.10 - 37.65)
Transplantation		
Without float-seat	129.03 ± 9.03 (115.4 - 142.9)	37.42 ± 0.31 (36.95 - 37.90)
With float-seat	103.0 ± 4.33 (95.2 - 109.1)	37.29 ± 0.24 (36.5 - 37.6)

Mean ± SD, (Figures in the parentheses indicate range). n = 15

6. Easy to carry as it is very light.
7. It may be used in any level of water in the field.

6.2 Recommendations for Future in-Depth Studies :

1. Further studies should be undertaken to suggest ergonomic and commercially viable and cheaper design of the float-seat.
2. Studies should be done on a large number of workers for the effects of group-behaviour on productivity.
3. Studies on electromyography and energy expenditure using socially acceptable monitoring instruments should be undertaken during longer period of work, without and with the float-seat.

From the above mentioned results it can be concluded that the existing manual process of drawing out seedlings from the seed bed and transplanting them with hand, unergonomic and awkward posture leads to physiologically heavy work. This can be improved by the use of low-cost, air inflated, light weight and easily transportable seat suitable for work in water-logged work places. The new sitting arrangement revealed greater productivity, lower physiological cost, lower wastage of time and energy, reduction of pain, with facilities for shorter work-rest cycles than those in the existing method.

7. Summary

The present investigation was undertaken for the application of ergonomic principles to improve Indian agriculture.

The existing process of uprooting paddy seedlings

from the seed-bed and transplanting them in the field, filled with knee-deep water, requires awkward postures of bending the back for a considerable period of time with resultant fatigue.

A low-cost, air-inflated, light weight rubber seat was designed with which the worker can pluck the seedlings and transplant them later on to the prepared field while floating on water, in a sitting posture. The workers need not go to the boundary of the field to take rest, instead they can take rest on the floating seat itself.

A detailed time and productivity study on a group of fifteen workers along with the recording of pulse rate, oral temperature, etc., in a steady state condition during work, both with the use and without using the 'float-seat' was carried out. Moreover, the assessment of pain on the different regions of body and workers' subjective assessment to evaluate the new arrangements in comparison to the existing process were also undertaken.

The results revealed greater productivity, lower physiological cost and lesser wastage of time with the new arrangement of "float-seat" than in the existing process.
