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Performance evaluation of flow through paddy thresher

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■ **ABSTRACT :** Performance tests were conducted on the Research-Cum-Instructional farm of College of Agriculture Engineering, JNKVV Jabalpur in 2012. The performance and evaluation of flow through thresher was done at four feed rate selected considering two feed rate within specified limit and other two beneath the specified limit on basis of manufacturer rated input capacity *i.e.* 400kg/h. The thresher was driven with 7.5 hp electric motor for conducting the experiment. The crop used for study was Mahamaya variety which was easily available in JNKVV Jabalpur. The threshing material was stacked in four heaps of 375, 400, 425 and 450 kg gross weights (Neeraj, 1985). The threshing was conducted for one hour duration for each feed rate (kg/h). A flow through paddy thresher was evaluated in terms of threshing efficiency, cleaning efficiency, per cent unthreshed, broken, blown grain delivered from thresher as well as sieve overflow (%), sieve underflow (%) and energy consumption (KWh) to optimize the capacity of thresher (Kamble and Panwar, 1985). Threshing efficiency of 375 feed rates was maximum *i.e.* 98.3 per cent, while 98, 96.8 and 96 per cent obtained at 375, 425 and 450 feed rate, respectively. Cleaning efficiencies of 375 feed rate was maximum *i.e.* 97.1 per cent while at 375, 400, 425 and 450 feed rate were found 96.9, 95.8, and 99.6 per cent, respectively. Maximum percentage of unthreshed grain obtained at 425 and 450 kg feed rate were 3.14 and 3.36, respectively. Out of four feed rate the minimum percentage of unthreshed grain obtained 1.63 and 1.97 at 375 and 400 feed rate, respectively. Percentage of broken grain at 375, 400, 425 and 450 feed rates were 1, 0.8, 0.7 and 0.7, respectively. Blown grain percentage at 450, 375,400 and 425 feed rate were 3.45, 2.66 2.25 and 2.06, respectively. The cylinder speed for four feed rates 929,930,901 and 878 rpm while blower speed 2369, 2368, 2368 and 2368 rpm and straw walker strokes varies from 180, 178, 166 and 145 no/min, respectively. Optimum capacity of thresher may be taken at 400 kg/h feed which meets the recommandation of the manufacturer (Klein and Harmond, 1966).

■ **KEY WORDS :** Thresher, Paddy, Threshing performance, Power requirement, Safety

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Rice (*Oryza sativa* L.) is one of the most important cereal crops. It is staple food of over half of world's population. Rice is very intimately bound with the Indian economy and Asia being regarded its traditional home. India is one of the world's largest producers of rice, accounting for 20 per cent of all world rice production. Rice production in India was 53.6 MMT in the year 1980, which has reached to 134 MMT in 2011-12. Increase in rice production is due to increase in area and rice productivity per hectare. The crop yield has increased from 1,336 kg/ha to 1,751 kg /ha between the periods 1980 -1990. In Madhya Pradesh, rice is cultivated under area of 16.14 Mha with total estimated production of 16.13 MMT and productivity is 1008.75 kg/ha. Various configurations of the threshing mechanism like drum type, regular beater, hammer mill type, rasp bar type, spike tooth type and wire loop type have been developed for use in mechanical thresher which is either work on the principle of through type or axial flow (Alizadeh and Allameh, 2011). The advancement of power threshers has changed the scenario and high capacity thresher is much in demand. Threshing is an integral part of postharvest activities for cereal and legume reduce to low quality of paddy rice and grain loss. When the rice production increases, consequently the manual threshing becomes arduous. The timely threshing is essential to reduce post harvest losses and to spare power sources for carrying out other farm operation in time (Agha, 2004). In view of above, performance evaluation of a high capacity paddy thresher was conducted for to optimize capacity and efficiencies of thresher as per BIS norms and to assess the feasibility of thresher for farm size and custom hiring mode (Sharma, 1983).

■ METHODOLOGY

The material of construction of different component of the thresher is shown in Table A.

Table A : Material of construction of flow through paddy thresher

Sr. No.	Components	Materials
1.	Frame	Mild steel
2.	Shaft	Mild steel
3.	Feeding chute	Mild steel
4.	Threshing cylinder	Mild steel
5.	Concave	Mild steel
6.	Blower	Mild steel
7.	Straw walker	Wood
8.	Sieve	wood
9.	Beater arm	Mild steel
10.	Pulley	Cast iron
11.	Transport wheel	Cast iron
12.	crankshaft	Steel
13.	V- belt	Rubber
14.	bearing	Alloy steel
15.	Pulley	Galvanized iron

(Singh and Singh, 1981)

Threshing mechanism:

The threshing mechanism consist a rasp bar type cylinder and a concave made of mild steel bars. Threshing cylinder consist three mild steel drum on which six rasp bars are mounted at 175mm spacing. The threshing cylinder is supported at the two ends on the plane ball bearings on a shaft of size 33 mm. One end of the threshing cylinder has a pulley which receives power from electric motor. At the other end of threshing cylinder, a V- belt pulley of 255 mm size is mounted which transfers power to a blower shaft using 28 mm shaft size through a B- type V-belt of 2362 mm length and 15 mm width.

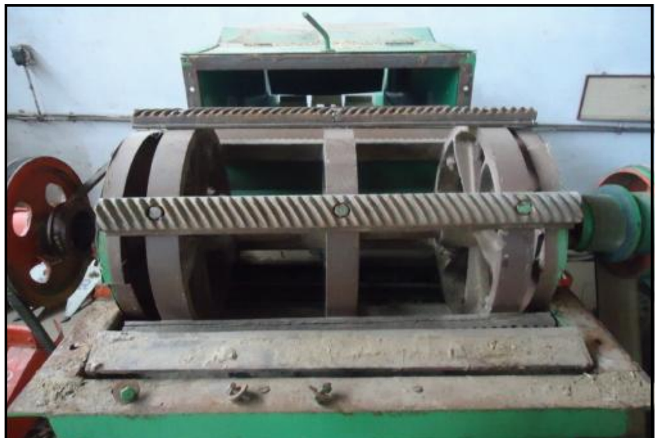

Plate A : View of threshing drum of thresher

Procedure:

The test was conducted at the university Farm. For testing, paddy crop (Mahamaya variety) was selected which was harvested manually. Before commencing the test, crop was stacked in heaps. Four heaps each weighing 375, 400, 425 and 450 kg crop were prepared consisting crop bundles of about 25 kg weight. Four replicates of each feed rate were prepared. These heaps were kept separate from each other. The paddy thresher was installed on a level ground on a hard surface and the concave clearance, screen slope were set as per manufacturer's recommendations.The cylinder speed was set to 1000 rpm (13.26 m/s) and the crop was manually fed to achieve the feed rate of 375, 400, 425 and 450 kg/h.

During the test, the blower speed, speed of crankshaft driving the straw walker, speed of primemower and number of oscillation of sieves there measured. The samples were collected at the end of straw walker as well as sieve overflow and underflow was measured. The energy consumed by the motor was also recorded using an energy meter. In order to estimate threshing efficiency, cleaning efficiency, unthreshed grain, broken grain, blown grain sieve overflow, sieve underflow samples were collected in for each selected feed rate (Cooper and Neel, 1978).

■ RESULTS AND DISCUSSION

The results obtained from the present investigation as well as relevant discussion have been summarized under following heads :

Threshing efficiency:

The threshing efficiency of the thresher on paddy crop (Mahamaya variety) was determined at 375, 400, 425 and 450 kg/h feed rate. The observed threshing efficiency is shown in Fig. 1. The figure indicates that the threshing efficiency was 98.3, 98, 96.8, 96 per cent at feed rate 375, 400, 425 and 450 kg/h feed rate. The threshing efficiency at feed rate of 375 and 400 kg/h was found almost same. However, it was found that, it decreased with increase in feed rate to 425 and 450 kg/h. This drop in threshing efficiency was due to the reason that with an increase in crop flow into a through inlet a thresher at higher feed rate, there is reduction in impact and rubbing forces on the crop causing reduction in detachment of grain from crop resulting in reduced threshing (Ige, 1978).

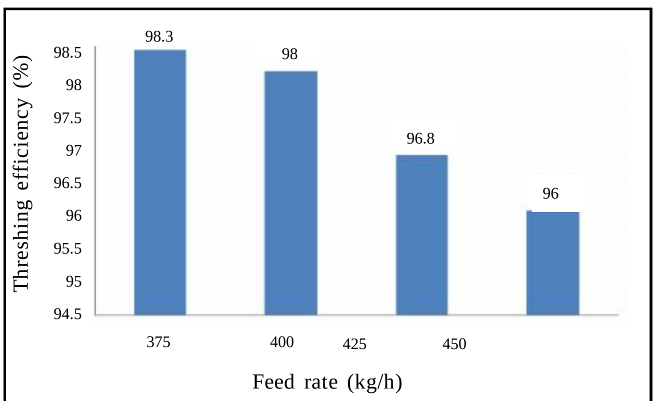

Fig. 1 : Effect of different feed rates on threshing efficiency (%)

Cleaning efficiency:

The cleaning efficiency of the thresher on paddy crop was determined at 375, 400, 425 and 450 kg/h feed rate. the observed cleaning efficiency is shown in Fig. 2. The figure shows that cleaning efficiency of 97.1, 96.9, 95.8, 95.6 per cent was observed at 375, 400, 425, 450 kg/h feed rate, respectively. There is decrease in cleaning efficiency with an increase in feed rate. The drop in cleaning efficiency is due to the reason that there is increase in more crop availability in the cleaning system at higher feed rate which causes reduction in separation of grain from straw and chaff present in the thresher.

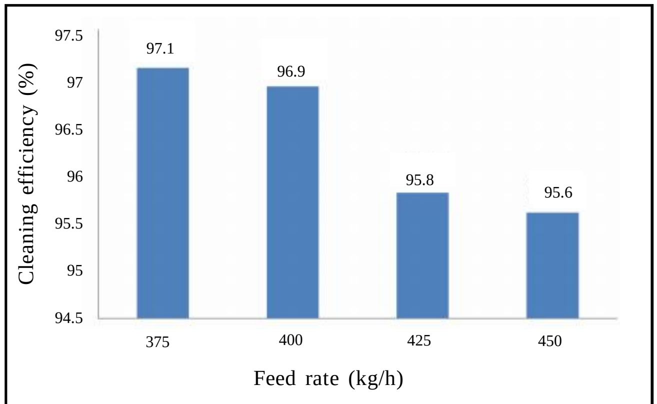

Fig. 2 : Effect of different feed rates on cleaning efficiency (%)

Unthreshed grain:

The per cent unthreshed grain at different feed rate threshing was determined and shown in Fig. 3. The figure shows that the unthreshed grain per cent was 1.63, 1.97, 3.14, 3.36 per cent at 375,400, 425, 450 kg/h feed rate, respectively. The minimum unthreshed grain per cent

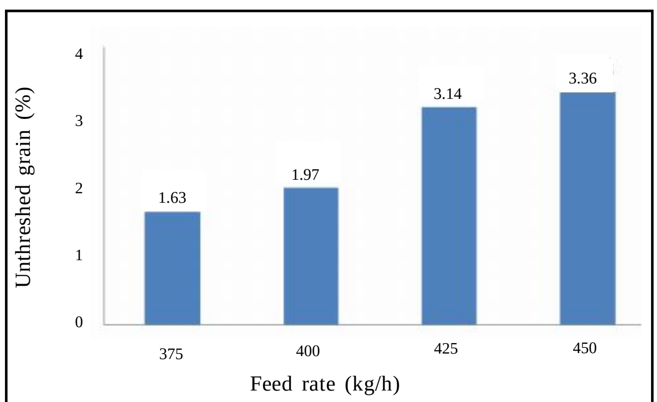

Fig. 3 : Effect of different feed rates on unthreshed grain (%)

was observed at 375 kg/h feed rate. The unthreshed grain from thresher increased with increase in feed rate. This increase is due to the reason that with an increase in feed rate the time available for threshing reduces, due to accumulation of more crops in threshing mechanism which causes more unthreshed grain to pass through with a mixture containing grain and crop residues.

Broken grain:

The per cent broken grain observed at 375, 400, 425 and 450 kg/h feed rate is shown in Fig. 4. The figure indicates that per cent broken grain was 1, 0.8, 0.7, 0.7 per cent at 375, 400, 425 and 450 kg/h feed rate, respectively. The observations show that with an increase in feed rate the broken grain per cent reduces and this may be due to the reason that at higher feed rate more cushioning effect occurs in a threshing mechanism causing less damage to the grain.

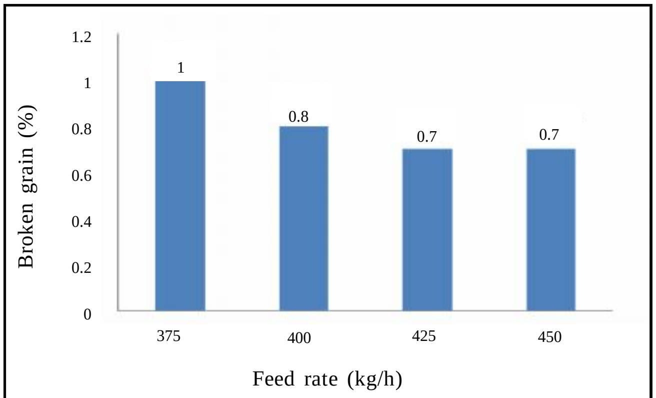

Fig. 4 : Effect of different feed rates on broken grain (%)

Blown grain:

The per cent blown grain from thresher at 375, 400, 425 and 450 kg/h feed rate is shown in Fig. 5. It is evident from the figure that the blown grain per cent was 3.45, 2.66, 2.25 and 2.06 per cent at feed rate of 375, 400, 425 and 450 kg/h, respectively. In a power thresher the blow grain per cent is generally more at lower feed rate and it reduces with increase in feed rate. This phenomenon is due to the reasons that at lower feed rate since the residual matter of crop is less, therefore, grains are picked up by air current produced due to aspirator or blower.

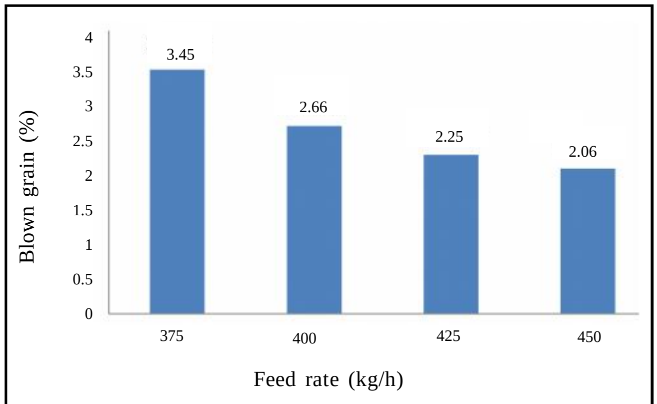

Fig. 5 : Effect of different feed rates on blown grain (%)

Sieve overflow:

The sieve overflow from the thresher was determined at 375,400,425 and 450 kg/h feed rate and is shown in Fig. 6. It was found to be 1.55, 1.73, 1.90, 2 per cent at feed rate of 375, 400, 425 and 450 kg/h feed rate, respectively. The observations clearly indicate that sieve overflow increased with increase in feed rate. This is probably due to the reason that as the sieves separate grain from straw and chaff, more of straw and chaff are present at higher feed rate affecting sieving of the grain as the sieve sets to continue to operate at a particular fixed setting.

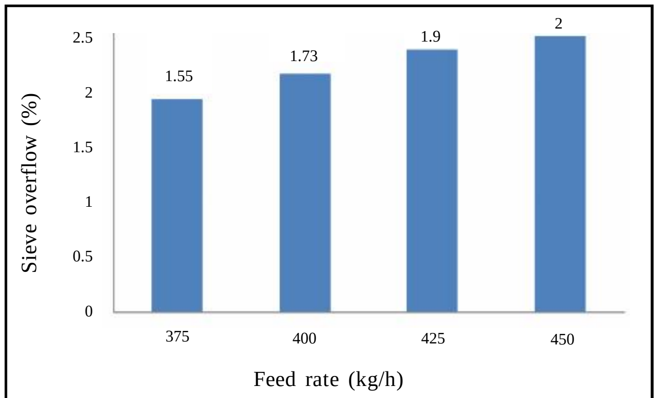

Fig. 6 : Effect of different feed rates on sieve overflow (%)

Sieve underflow:

The sieve underflow was determined at 375, 400, 425 and 450 kg/h feed rate and shown in Fig. 7. It was found to be that the sieve underflow 1.07, 1.41, 1.56, 1.68 per cent at 375, 400, 425 and 450 kg/h feed rate, respectively. The sieve underflow also increased with increase in feed rate due to the obvious reason that an increase in feed rate causes more material to accumulate in cleaning system causing less separation of grain from crop residues and it gets discharged through sieve.

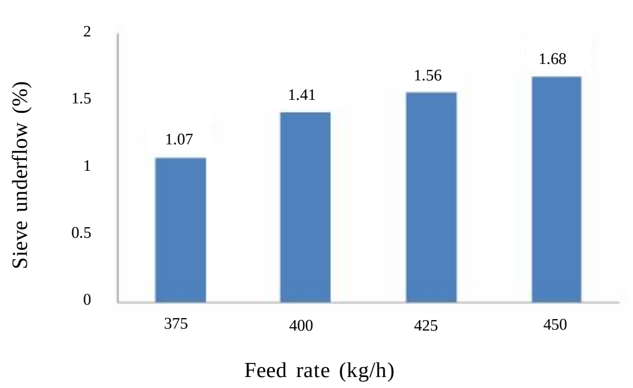

Fig. 7 : Effect of different feed rates on sieve underflow (%)

Conformity with BIS norms:

The bureau of Indian standards, new Delhi in IS 9020 : 2002 has specified safe discussion of feeding chute as well as requirement of different guards in power transmission system to prevent accidents, In view of above a comparison was made as shown in Table 1.

Cost of threshing:

The cost of threshing was calculated for all feed rates considering yield of paddy 4000 kg/ha and yearly working hours as 312 h. The cost estimation was calculated in accordance IS: 9164 - 979 on the basis of annual working hours and annual useful life of a machine which shown in Table 2. The cost estimation was done for fixed cost, variable cost and electrical cost which is shown in Table 2. The cost varies from 1340.6, 1271.6, 1200 and 1051.6 Rs./ha at 375, 400, 425 and 450 feed rate, respectively.

Command area of thresher:

In order to establish thresher by farmer the rise of land holding *i.e.* minimum area on which paddy must be grown was calculated taking optimum feed rate (400 kg/h) as basis. The yield of paddy was taken to be 40q/ha and yearly working hours as 312 h (IS: 9164-1979), at the above assumption it can be estimated that using

Table 1 : System of BIS norms specification

Sr. No	Name of the component	L (mm)		W (mm)		Chute angle with cover portion		Thickness of sheet (mm)	
		BIS	Actual	BIS	Actual	BIS	Actual	BIS	Actual
1.	Feeding chute	900	1180	450	760	10^0-30^0	14^0	1.6	1.5
2.	Size of feeding chute opening	220	560	190	80	5^0	2^0	1.6	1.5
3.	Protection measures						Availability		
						Yes		No	
	From motor to cylinder pulley					-		No	
	Cylinder pulley to crankshaft					-		No	
	Cylinder left shaft to blower shaft					-		No	

(IS, 1985)

Table 2 : Cost of threshing at different feed rates

Sr. No.	Particulars	Sub particulars	Feed rate (kg/h)			
			375	400	425	450
1.	Fixed cost (Rs./ha)	Depreciation (Rs./h)	243	228	214.5	202.6
		Interest (Rs./h)	128.9	120.9	113.7	107.4
		Insurance and taxes (Rs.)	40.9	38.2	36.1	34.1
		Housing (Rs.)	30.7	28.8	27.1	25.6
2.	Variable cost (Rs./ha)	Repair and maintenance (Rs.)	19.8	18.2	16.62	15.2
		Wages and labour charges (Rs.)	799	750	705.7	666.7
3.	Electrical cost (Rs./h)		78.3	87.5	85.6	87.1
	Total cost (Rs./ha)		1340.6	1271.6	1200	1051.6

(IS: 9164, 1979)

this thresher about 1170 quintal of paddy can be threshed per year which would be available for about 31 ha land. Thus, considering ownership by an individual farmer the thresher can be finding inside use in customer hiring services also.

Conclusion:

Studies based on evaluation of above parameters deciding about the capacity of thresher and quality of threshing. It can be conclude that threshing efficency, cleaning effciency, sieve overflow, sieve underflow, broken grain percentage from the threhser at the feed rates of 375 and 400 kg were comparable. Hence, optimum capacity of thresher may be taken at 400 kg/h feed which meets the recommandation of the manufacturer.

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REFERENCES

Agha (2004). Grain losses of wheat as affected by threshing timings. *Agril. Biol. J.*, **6** (3) : 6.

Alizadeh, M.R. and Khodabakhshipour, M. (2010). Effect of threshing drum speed and crop moisture content on paddy grain damage in axial-flow thresher. *J. Agronomic.*,**43** (4):144.

Alizadeh, M.R. and Allameh, A. (2011). Threshing force of paddy as affected by loading manner and grain position on the panicle. *J. Res. Agric. Engg.*, **57**(1): 8-12.

Bhadiyadra, B.K. and Joshi, H.C. (1974). Design and development of sunflower thresher. Thesis, B. Tech Agricultural Engineering, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand (India).

BIS (2002). Power thresher safety requirements.

Buchanan, J.C. and Jonson, W.H. (1964). Functional characteristics and analysis of a centrifugal threshing and parating mechanism. *Trans. of ASAE*, **7** (4) : 460-463.

Chhabra, S.D. (1975). Studies on threshing of paddy and wheat by axial flow thresher.Thesis, M. Tech Agricultural Engineering, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand (India).

Chhabra, S.D. and Singh, K.N. (1977). Studied on effect of cylinder speed and peg spacing of axial flow thresher on wheat threshing. *Agril. Engg. J.*, **14** (4) : 141-144.

Chukwa, O. (2008). Performance evaluation of locally manufactured rice thresher in niger state. *Engg. Appl. Sci. J.*, **3** (7) : 606-607.

Cooper, G.F. and Neel, A.E. (1978). Performance testing of combine in lab. *Agric. Engg.*, 397-399.

Delong, H.H. and Schwantes, A.J. (1942). Mechanical injury in threshing barley. *Agric. Engg. ASAE*, **23**(1) 45-51.

Dilday, R. H. (1987). Influence of thresher cylinder speed and grain moisture at harvest on milling yield of rice, *J. Arkansas Academy of Sci.*,**41** (12) : 36-37.

Engr, C.O.O. (2011). Simulation and optimization modeling of performance of a cereal thresher. *Internat. J. Engg. & Technol. JENS.* ,**11**(3):143.

Ezzatollah, A., Gillandeh, Y.A. and Abbasi, S. (2009). Study of performance parameters of threshing unit in a single plant thresher. *Agric. & Biological Sci. J.*, **4** (2) : 92-96.

IS (1985). Test code for power thresher for cereals.

IS, test code for cost estimation.

Kamble, H.G. and Panwar, J.S. (1984). Studies on machine crop variables for threshing of moong. *J. Agric. Engg.*, **21**(4): 1-7.

Kamble, H.G. and Panwar, J.S. (1985). Effect of machine crop variables on threshing of pea. *J. Agric. Engg.*, **22** (4): 11-18.

Kamble, H.G. and Panwar, J.S. (1988). Threshing parameters of pigen pea. Paper presented at XXIV ISAE Convention held at Punjabrao KrishiVidyapeeth, Akola on January 21-23.

Kashyap, M.M. and Pathak, B.S. (1976). Effect of air stream depth on air velocity requirement for winnowing operation. *J. Agric. Engg.*, **13** (4) : 172-176.

Lamp. B.J. Jr. and Buckel, W.F. (1960). Centrifugal threshing of small grains. *Trans. of ASAE*, **3** (2): 24-28.

Mahmoud, M.A. Moheb, M.A. E. and Mahmoud, K.H. A. K. (2007). Development of feeding device in aturkish threshing machine. *Misr J. Ag. Engg.*, **24** (2) : 235-258.

Mehta, M.L. and Sharma, V.K. (1985). Studies on threshing system of chaff-cutter type thresher. *J. Res. PAU*, **22**(4): 735-741.

Nag, P. and Nag, A. (2004). Drudgery and injuries in Indian agricultural.*National Institute of Industrial Health*, **42**:149-162.

Neeraj (1985). Performance evaluation of pigeonpea threshing methods.Thesis, M. Tech Agricultural Engineering, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand (India).

Prasanna, P.H.S.N. Gunaratne, L.H.P. and Withana,

W.D.R.S. (2004). Compare economic analysis of paddy threshing methods. *Sri Lankan J. Agric. Econ.*, **6**(1):12-15.

Rajesh, K. N. (2010). Effect of crop and machine parameters on performance of paddy thresher, *Agric. Engg.*, **34** (1): 30-32.

Singh, Bachchan (1975). Environmental effects on navy bean field drying and harvesting. Ph.D. Thesis, Michigan State University, East Lansing.

Singh, K.N. (1977). System analysis of soybean threshing methods.Thesis, M. Tech Agricultural Engineering, G. B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand (India).

Singh, K.N. and Joshi, H.C. (1977). Design and development of rice culture machinery for different power sources. Progress report for ad-hoc I.C.A.R. research project. Agricultural Engineering, G.B. Pant University of Agriculture and Technology, Pantnagar, Uttarakhand (India).

Singh, K.N. and Singh, B. (1981). Effect of crop and machine parameters on threshing effectiveness and seed quality of soybean. *J. Agric. Engg. Res.*, **26** (4) : 349-355.

Ukatu, A.C. (2006). modified threshing unit for soyabean. *Citation Biosystems Engineering,* **95** (3) : 371-377.