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Innovative Cotton Harvesting Bags

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Abstract – **Innovative cotton harvesting bag (ICHB) was designed by Ms. Sunita Chauhan of Farm Science Centre, Central Institute for Cotton Research, Nagpur. ICHB was most acceptable for ease in tying, picking, emptying, load carrying and ergonomically efficient compared to other back and front loaded cotton harvesting bags. Significantly 42% higher cotton was harvested and area covered hour-1 over traditional system. ICHB was most efficient in cotton picking with 86% higher output of cotton harvested and cotton harvest area covered heart beat -1 among all cotton pickings. Ergonomics of cotton harvesting was significantly influenced by pickings, time of harvest, age of cotton harvesters in Bt hybrid cotton.**

Keywords – **Cotton Harvesting Bags, Drudgery Reduction, Manual Cotton Harvesting, Innovative.**

I. INTRODUCTION

Wide spread adoption of Bt hybrid cotton with its synchronised boll bursting during 2005-2007 brought lot of changes in manual cotton harvesting in rural India due to limited availability of harvesting time and women harvesters resulted rise in the cost of seed cotton harvesting chages US $ 0.03-0.13/ kilogram-1[2]. Cotton harvesting manually involves moderate drudgery due to posture, load of picked cotton and abrasion of fingers [3][5][8]. Hand harvesting operation requires 450-500 women-hr ha-1 which costs US$ 79-248 ha1 [4][5]. Big boll size, long to extra long cotton fibres with G. barbadense cotton whose dehisced boll beaks were sharp, can not open more than 180o angle therefore, abrasive to the fingers and forearms of cotton harvestors. Labour shortages for harvesting had been experienced in intensively cultivated states due to synchronization and early maturity by a month which narrowed the harvesting window besides increased the load on limited available rural women [7]. Cotton harvesting bag went a sea change in adapting to Indian cotton harvesting [9]. Cotton harvesting bags were designed, tested and popularized to improve cotton harvesting efficiency and reduce trash content [1]. Cotton harvesting bag aided to reduce drudgery, efficient collection and field transportation of manual cotton harvesting [3]. There was no increase in harvesting efficiency due to energy variability among harvestors but certainly reduced drudgery as they were ergonomic [5]. Present onfarm adoptive research was concentrated on designing and evaluation of superior cotton harvesting bags suitable for cotton harvesting season of mild winters to moderate summer in Vidarbha region of Central India in participatory mode by contract manual cotton harvesting women in small farms.

II. METHODOLOGY

2.1 Site weather conditions:

ICHB was evaluated for the ergonomics, acceptability, suitability and comfort during 2011-12 cotton season in Nagpur district of central India, which is the hub of rainfed cotton production in Vertisols. Weather conditions during the harvesting season were mild winters to moderate summers during November to January months.

2.2 Innovative cotton harvesting bag:

A new innovative cotton harvesting bag was designed [Fig.1.] by Ms. Sunita Chauhan, SMS, Farm Science Centre, Central Institute for Cotton Research, Nagpur. Experiences with front loaded cotton harvesting bags from Home Science Department, Marathwada Agriculture University, (MAU), Parbhani [Fig.2.] and Chineese battery operated small farm cotton picker, besides back loaded cotton harvesting bag [Fig.3.] of Family Resource management Division, Chaudhary Charan Singh Haryana Agriculture University (CCS, HAU), Hissar (Gandhi *et al.* 2008) were evaluated between 2008-2011 [5] under Technology assessment and refinement (TAR). Hall mark of new innovation is easy to wear requires less cloth, equal distribution of load, head and forearms protection besides higher carrying capacity to improve harvesting efficiency by reduced time on frequent emptying.


Fig.1. CICR, bag

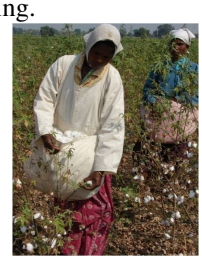
Fig.2. MAU


Fig.3. HAU, bag


Fig.4. Conventional

2.3 Stitching of bags:

Cotton harvesting bags alongwith technical literature were procured from original source (MAU, Parbhani, CCS, HAU, Hissar) and stitched to assess their suitability

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for cotton harvesting women folk of Nagpur district. ICHB was compared with both front (MAU) and back loaded bags (HAU, CICR), with and without sleeves for arm protection with traditional system of a piece of cloth tied around waist, old full sleeves male shirt, old petticoat for body protection of a female labourer which is a popular practice followed in Central India [Fig.4].

2.4 Selection and training of subjects:

Contract farm women were paid on weight of seed cotton harvested with normal health/ blood pressure and body temperature were selected from Nagpur district, Maharashtra state, India. Cotton harvesters with 18-50 age were used for contract cotton harvesting in farmers fields. Knowledge and skills for using these harvesting bags were imparted and allowed them to use for dummy harvesting. Option to choose cotton harvesting bags was left to contract manual harvestors only and therefore, variable numbers were considered while statistically analyzing the probabilities.

2.5 Evaluation cotton harvesting bags:

Output of Bt hybrid cotton picked was measured per unit area and time using all harvesting bags and local harvesting aid called *Fadka* or a piece of old cotton /synthetic cloth usually tied around the waist of cotton harvesting women to temporarily store and transport cotton picked in field. Ergonomics of load carrying in field and transportation by head load carrying to home was also estimated by heart rate monitor. Delta heart rate was computed by Heart rate monitor at rest and average during work time.

2.6 Computations:

Out puts of area covered and seed cotton harvested hr^{-1} delta heart $beat^{-1}$ were calculated and conclusions were based on 't' test compared with traditional system of manual cotton harvesting time. Age, lunch, picking time, number of picking and their effects were also studied to understand the variability caused by these factors on Bt hybrid cotton manual harvesting with cotton harvesting bags.

III. Results and Discussion

3.1 Bt hybrid cotton picking:

Conventional hybrid cotton was to flower 50 to 140 DAS and harvested 135 and 240 DAS in rainfed and supplemental irrigations where family labour was engaged to pick cotton (6-8 times) with occasional hiring from the same village. After the adoption of Bt hybrid cotton synchronization of boll bursting with more intensity of bolls per unit area reduced the cotton harvesting window 3 to 2 months in supplemental and rainfed conditions reducing the number of pickings from 6-3 respectively. Bt hybrid cotton wide spread adoption resulted in migration of hired labour from outside villages, transportation of labour to fields cost need to be born by the cultivators and indirectly labour health and fitness problems due to more intensity of workload adversely affected cotton harvesting in rural central India demanding higher harvesting price kg^{-1} harvesting of cotton leaving lower margins to small farmers.

3.2 Pickings on harvesting cost and efficiency:

Significantly higher picking output and earliness of Bt hybrid cotton in 1st pick compared to later two were observed from the data of Table 1. Last picking was half of that of 1st pick per unit work load on heart. Boll opening was half of 1st picking, therefore, significantly covered double the cotton area in later two pickings needs more idle time in field walking. Hence labourers started demanding higher wages in later picks or as per clock time basis which costed farmers US $ 0.13-0.20/kg^{-1} seed cotton harvesting. These observations were in agreement with rise in picking cost [2].

3.3 Age of cotton harvesters:

Significantly lowest output of seed cotton harvested hr^{-1} was harvested in 3rd picking of cotton by the 40-50 years old cotton harvesters which needs more field walking due to lesser bolls $plant^{-1}$ (Table 2). Similarly, they were also covered significantly lowest cotton area per hour in both later cotton pickings (2nd, 3rd). Significantly lowest area was covered per energy spent by in 2nd picking by both 26 to 50 years aged cotton harvesters.

Table 1: Manual harvesting efficiency of Bt hybrid cotton in different harvestings.

Harvesting	Cotton harvested kg hr^{-1}	Pvalue	Cotton harvested kg delta HB^{-1}	Pvalue	Harvested Area M^2 hr^{-1}	Pvalue	Harvested Area M^2 delta HB^{-1}	Pvalue
1st	6.31		0.498		38.1		3.14	
2nd	5.51	0.026	0.465	0.31	98.9	$4.66x10^6$	8.85	$4.1x10^5$
3rd	5.16	0.012	0.252	$2.59x10^6$	80.0	0.002	4.09	0.13

3.4 Harvesting time:

Manual contract harvesters takeup the harvesting work from 8.00 am to 17.30 hrs with a lunch break at 13.30 hrs. Initial higher output reduces towards lunch time and lowest efficiency after usual heavy lunch was followed by picking to reach normal level after proper digestion in a hour. Significantly least seed cotton was harvested hr^{-1} in the 3rd picking post lunch session [Table3] which needs more field movement. Significant effect of lunch time was visible in output of cotton harvested kg HB^{-1}, harvesting area covered M^2 hr^{-1} in 1st and 2nd picking and area covered M^2 HB^{-1} in 1st picking.

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Table 2: Manual harvesters age on Bt hybrid cotton harvesting efficiency

Harvesting	Age years	Cotton harvested kghr^{-1}	Pvalue	Cotton harvested kg delta HB^{-1}	Pvalue	Harvested Area M^2 hr^{-1}	Pvalue	Harvested Area M^2 delta HB^{-1}	Pvalue
P1	26	6.39		0.515		41.1		3.44	
P1	37	6.40	0.49	0.500	0.44	37.8	0.26	3.07	0.32
P1	50	5.34	0.10	0.419	0.29	29.1	0.04	2.46	0.16
P2	26	5.31		0.511		93.5		9.39	
P2	37	5.76	0.25	0.423	0.23	109.9	0.17	4.34	0.042
P2	50	4.71	0.10	0.516	0.48	47.5	0.0005	5.13	0.05
P3	37	5.90		0.264		87.5		4.02	
P3	50	3.99	0.008	0.233	0.25	68.3	0.20	4.21	0.44

Table 3: Picking timewise Bt hybrid cotton picking efficiency in participatory mode

Harvesting		Cotton harvested kghr^{-1}	Pvalue	Cotton harvested kg delta HB^{-1}	Pvalue	Harvested Area M^2 hr^{-1}	Pvalue	Harvested Area M^2 delta HB^{-1}	Pvalue
P1	Pre lunch	6.12		0.543		39.2		3.68	
P1	Post lunch	6.39	0.12	0.416	0.054	84.9	0.0001	2.16	0.007
P2	Pre lunch	5.65		0.561		84.0		9.62	
P2	Post lunch	5.35	0.32	0.362	0.017	116.5	0.027	7.93	0.25
P3	Pre lunch	7.19		0.343		137.6		6.88	
P3	Post lunch	4.60	0.042	0.226	0.065	63.99	0.12	3.32	0.15

3.5 Ergonomics of cotton harvesting bags:

Lowest acceptability was for front loaded cotton harvesting bags with hand protection which restricted forward movement in field, gave severe neck pain and suffocation to pickers (16) compared to maximum for cotton innovative harvesting bag of Farm Science Centre, Nagpur which was tailor made for ease of tying, picking, emptying with higher carrying capacity with maximum acceptability of 72 cotton harvesters. Cotton harvesting bag of FSC, CICR, Nagpur harvested 42% higher cotton harvest and cotton area covered hour^{-1} over traditional system in 3rd picking and most efficient cotton picking with 86% higher out put of cotton harvest and area covered HB^{-1} in all three pickings [Table 4]. These results were in agreement with back loaded cotton harvesting bag [6].

IV. Conclusion

New innovative cotton harvesting bag design by Ms. Sunita Chauhan, Farm Science Centre, Nagpur was most acceptable with significantly 42% higher seed cotton was harvested and cotton harvest was area covered hour^{-1} over traditional system and most efficient cotton picking with 86% higher out put of cotton harvested and area covered HB^{-1} in all pickings.

Table 4: Ergonomic evaluation of different cotton harvesting bags

Cotton harvesting bags & Subject Nos	Cotton harvested kghr^{-1}	Pvalue	Cotton harvested kg delta HB^{-1}	Pvalue	Harvested Area M^2 hr^{-1}	Pvalue	Harvested Area M^2 delta HB^{-1}	Pvalue
Traditional system								
P1(17)	6.45		0.349		36.03		1.81	
P2(21)	5.84		0.325		96.2		6.21	
P3(8)47	4.08		0.166		56.6		2.27	
HAU bag								
P1(15)	5.63	0.08	0.352	0.47	40.4	0.30	2.78	0.089
P2(21)36	6.07	0.42	0.560	0.05	73.93	0.15	6.65	0.42
MAU Bag								
P1(7)	7.53	0.15	0.435	0.22	42.3	0.23	2.54	0.20
P2(8)	5.36	0.30	0.232	0.09	117.6	0.25	7.24	0.40
P3(1)16	4.80		0.330		49		3.4	
CICR Bag								
P1(34)	6.41	0.42	0.672	0.0008	38.2	0.37	4.25	0.0001
P2(24)	4.88	0.035	0.597	0.008	112.6	0.24	13.31	0.02
P3(14)72	5.78	0.015	0.295	0.0005	95.6	0.045	5.2	0.013

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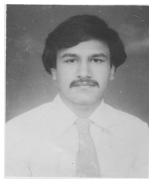
AUTHOR'S PROFILE

Ms. Sunita Chauhan

was born at Nagpur (M.S.) in 1966. M. Sc, M Philosophy. in Home Science from LAD & RP College, RSTM, Nagpur University in 1989 and 1991. She has joined as SMS in Farm Science Centre, ICAR, CICR, Nagpur in 1997. She is interested in drudgery reduction of farm women through small farm mechanization and improving their nutritional status through appropriate interventions in participatory mode. She has worked on harvesting of Field & vegetable crops and bio-waste recycling to meet the rural organic fertilizer and house hold energy needs. She has authored one book chapter, one technical bulletin, Radio & TV Talks and 4 journal papers.



Ambati Ravinder Raju

was born in Chalvai village, Warangal district, Andhra Pradesh state, India on 16th August.1962. Grauduated and Post graduated in Agronomy discipline in 1983, 1985 from College of Agriculture, Nagpur. He served for one year at ANC, Warora(M.S) as lecturer in Crop Science. He has passed ARS in 1986 and joined service in 1989 at Central Institute for Cotton Research, Indian Council of Agriculture and Research, Nagpur after completion of his Ph. D from Post Graduate Institute, Dr. *Punjab Rao Deshmukh* Agriculture University, Akola(M.S) India. He has an extensive Research and Extension experience 25 years in Cotton production. His research interests include Rain water conservation, harvesting and recycling in farm ponds through drip/ fertigation, Plant population and yield plateau, Biological nitrogen fixation(BNF), P solubilisation/ mobilization by fungal, bacterial and *mycorhizal* associations, Micro and Secondary nutrition of soybean-Bt and non Bt hybrid cotton, Strip and intercropping, mechanization of small farms, herbicide tolerant weeds and their management in sole, inter and rotational crops. He is the author of Seven books and 25 journal papers.

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