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Performance analysis of Conoweeder to combat drudgery involved in weeding of paddy

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Abstract
Bhut Jolokia has great demand in the pharmaceutical industries for its richness in capsaicin, carotenoids and ascorbic acid content. Its nutritional content can vary between different genotypes and area. In the present study sixteen genotypes of king chilli from different states of North East India were collected and analyzed to quantify their dry fruit yield, ascorbic acid contents, capsaicin content, α-Carotene and ß-carotene. The result indicated that dry fruit yield (0.01-0.04 kg/plant), ascorbic acid contents (92.07-301.11 mg/100g), capsaicin content (0.75-4.65 %), α-Carotene (1.02-5.26 mg/L) and ß-carotene (0.97-4.45 mg/L) ranged between the sixteen genotypes. The genotype CHFKC-6 showed maximum content of capsaicin content and it can be utilized for pharmaceutical use. While the genotype CHFKC-1 was good for ascorbic acid content and β-Carotene. CHFKC-15 has average for ascorbic acid, α-Carotene and β-Carotene content.

Keywords: Conoweeder, pharmaceutical

Introduction
Agriculture is the mainstay of Indian Economy. It has to support almost 17 per cent of world population from 2.3 per cent of world geographical area and 4.2 per cent of world's water resources. At present, the women found in the work force in agriculture and allied sectors are estimated at about 61 million which amounts to about 30 per cent of the total rural workers. The Indian women work for about 14-16 hours a day to carry out various activities on farm and at home. (Oberoi and Gill 2003) Rice *Oryza sativa* is a cereal grain, it is the most widely consumed staple food for a large part of the world's human population, especially in Asia. According to data for 2010, paddy is one of the chief grains of India. Moreover, this country has the biggest area under rice cultivation, as it is one of the principal food crops. It is in fact the dominant crop of the country. India is one of the leading producers of paddy

Kanpur Dehat is situated in the middle of Holy Ganga & Yamuna River. This is agriculturally dominating district. Abot 83% rural population by and large depends on agriculture. Cropping intensity in the district is around 136.25% as against 200% ideally. Paddy is 2nd largest grown crop of Kanpur Dehat as 53749 hactare of total cultivable land is covered by the crop.

Women play a major role in rice cultivation, this is one of that crop in which involvement of women is, maximum, throughout the world, rural women historically have played, and continue to play an important role in rice farming systems. In India women carry out as much as 80 percent of the work in paddy production (Singh and Tiwari, 2009) [5]. They undertake much of the back-breaking labor in rice production, including tasks such as transplanting, weeding, harvesting and winnowing. Drudgery of Farm women is an important aspect that has attracted wide attention of researchers. If measured by the extensiveness and intensiveness of their involvement, farm women shoulder much more burden than men. Importantly, women are involved in more strenuous activities as compared to men. The awkward posture and static load exert strain on the cardiovascular system the musculoskeletal system may endure substantial performance limitations. Most tasks are performed with bare hands and feet and involve awkward postures as well as highly repetitive movements. These work factors have previously been found to lead to musculoskeletal disorders. Weeding in paddy is performed in both bending and squatting posture continuously for the whole day. The work posture has a direct correlation with heart rate energy expenditure and physiological workload. It is difficult to maintain any posture for a long time due to fatigue resulting from static muscular effort. There is a need to quantify the drudgery involved in paddy weeding and available technologies, which can be transferred to reduce the stress and increasing efficiency, thereby, improving health and well being of women.

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On this ground On farm Trials on performance analysis of conoweeder were planned with following specific objectives.
1. Quantification of drudgery and MSD involved in weeding activity of paddy crop and
2. Efficiency analysis of conoweeder for wet land paddy weeding.

Material and Methods
Descriptive cum experimental research design was followed to carry out the research. The study was conducted on 90 randomly selected farm women of Rania and Karsa Village of sarwankheda block and Lodhar village of Kalyanpur block in year 2015, Rudapur, Aurangabad and Majhiyar Village of Maitha Block in the year 2016 and Daleep Nagar, Basen and of Shivrajpur block and Kakardahi of Maitha block in the year 2017. 30 farm women from each village were selected every year. Experiments were conducted on 40 percent physically fit farmwomen under the On Farm Trial in district Kanpur. Data were collected with the help of pre-structured interview cum observation schedule. Measurements were done for the Height, Weight, BMI, and Physiological parameters viz: physiological cost of work, percent change in grip strength, muscular pain and performance parameters of conoweeder were assessed by the equipments designed for the purpose. Polar Heart rate monitor and Grip Dynamometer were used to measure heartbeat/min and grip strength respectively. Other equipment used were measuring tape weighting balance and stop watch. Following formula were used to calculate PCW, energy expenditure and Percent Change in Grip Strength while performing weeding manually and through conoweeder as well.

A. Physiological Cost of work
TCCW = Cardiac cost of work (CCW) + cardiac cost of recovery (CCR)

AHR = Average working heart rate (AWHR) – Average resting heart rate

CCW = Average hear rate (AHR) x Duration of activity

CCR = Average recovery heart rate – Average resting heart rate x duration of activity

PCW = Physiological cost of work / Total time of activity

B. Energy expenditure (kj/min)= 0.159 x average working rate – 8.72

C. Change in Grip Strength = : Sr –Sw / Sr X 100

Where
Sr= Strength at rest
Sw= Strength at work

Details of Technology: Conoweeder is developd by TNAU, Coimbatore for weeding in wet land paddy crop. Field capacity is 0.18/ha perday.

Results and Discussion
Socio-economic Profile of Respondents: examines social and economic factors to better understand how the combination of both influences something. Socio-economic profile of the respondents under study is presented in table 1.

Table 1: Distribution of Respondents on the basis of Socio- Economic Profile N=90 Each year

S. No.	Particulars	Frequency			Percentage		
		2015	2016	2017	2015	2016	2017
a. Age							
1	25-35	58.00	54.00	51.00	64.44	60.00	56.67
2	36-45	17.00	20.00	23.00	18.89	22.22	25.56
3	46-55	10.00	9.00	8.00	11.11	10.00	8.89
4	<55	5.00	7.00	8.00	5.56	7.78	8.89
b. Education							
1.	Illiterate	52.00	57.00	43.00	57.78	63.33	47.78
2.	Up to primary	15.00	19.00	21.00	16.67	21.11	23.33
3	Up to Middle school	13.00	10.00	18.00	14.44	11.11	20.00
4	Up to High School	10.00	4.00	8.00	11.11	4.44	8.89
c. Caste							
1.	General	7.00	13.00	16.00	7.78	14.44	17.78
2.	Backward Caste	30.00	23.00	22.00	33.33	25.56	24.44
3	Schedule Caste/Schedule Tribes	53.00	54.00	52.00	58.89	60.00	57.78
d. Monthly Income of Family from all sources (Rs.)							
1.	Up to 10000	43.00	48.00	39.00	47.78	53.33	43.33
2.	10000- 15000	19.00	26.00	25.00	21.11	28.89	27.78
3.	15000-20000	16.00	12.00	22.00	17.78	13.33	24.44
4.	<20000	12.00	4.00	6.00	13.33	4.44	6.67
e. Type of Family							
1.	Nuclear	68.00	71.00	75.00	75.55	78.89	83.33
2.	Joint	22.00	19.00	15.00	24.44	17.78	16.67
f. Size of Family							
1.	Up to 4 members	40.00	34.00	48.00	44.44	36.78	53.33
2.	5-7 members	35.00	50.00	25.00	38.89	55.56	27.78
3	8 and above	15.00	6.00	17.00	16.67	6.67	6.67
g. Body Structure							
1.	Ectomorph	30.00	34.00	25.00	33.33	37.78	27.78
2.	Mesomorph	43.00	49.00	52.00	47.78	54.44	57.78
3.	Endomorph	17.00	7.00	13.00	18.89	7.78	14.44

As per the table 1 majority of the respondents were from25-35 years age group in all the years, followed by 18.89,22.22 and 25.56 who were from 36-45 years age group in 2015, 2016 and 2017 respectively. Less than 10.00 percent respondents

were belonged to < 55years of age group in all the three years. Majority (57.78%, 63.33% and 47.78&) of respondents were illiterate where as 16.67, 21.11 and 23.33 percent from year 2015, 2016 and 2017 respectively were primary level educated. Very few i.e. only 11.11, 4.44 and 8.89 percent respondents in 2015, 2016 and 2017 respectively were educated up to high school level**.** More than fifty five percent respondents belonged to Schedule caste followed by 33.33, 25.56 and 24.44 were from backward category in the year 2015, 2016 and 2017 respectively. Minimum respondents were from general caste in all the year women who are engaged in farming activity, either in their own farm or in others' as farm labour were purposively selected for study hence Cent percent respondent of all the three year were engaged in farming activity. Majority of respondents under study from all the three years were having Rs. up to 10,000 Family's monthly income from all sources. Followed by 21.11percent, 28.89 percent and 27.78 percent who were found having Rs 10,000-15000 from the year 2015, 2016 and 2017 respectively. Majority of respondents selected all the three years were belonged to nuclear family Majority of respondents of 2015 and 2017 were having up to 4memebers

in their family while in 2016 majority belonged to 5-7 member family. Majority of respondents selected all the three year were having Mesomorph body structure

Table 2: Physiological Characteristics of Respondents Selected for Experiment N= 36 each year

S. No.	Particulars	2015	2016	2017	Average
1	Mean Age (years)	36.23	34.70	35.30	35.41
2	Mean Height (cm)	150.01	152.00	153.1	151.70
3	Mean weight (Kg)	43.67	42.43	46.80	44.3
4	BMI (Kg/m^2)	20.77	19.97	20.19	20.31

Physical Characteristics of Respondents: Data scrutinized in table 2 reveals that mean age of all three years was 35.41years whereas, mean height was 151.70 cm. Mean weight of the respondents under study was 44.3 Kg and BMI 20.77 Kg/m$^{2.}$ All these Characteristics are denoting a good physical state. Figure-1 depicted Average Age, Height, Weight and BMI of respondents selected for experiment every year. Data in figure clearly states that respondents under study, as per demand are in good physical condition i.e. physically fit.
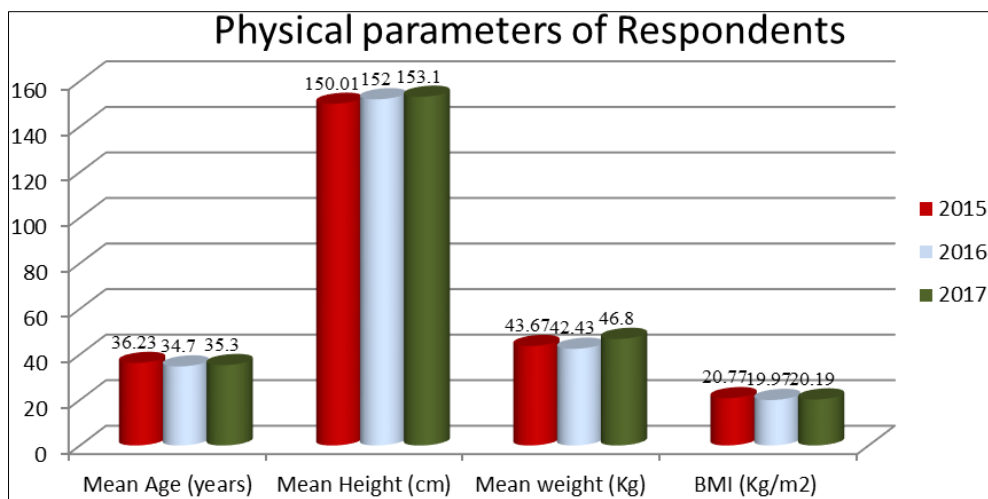
Fig 1: Physical parameters of the respondents for all study years.

Ergonomic Assessment: Heart rate is one of the accurate means to evaluate the physiological or functional demands of work on the worker. Table-3 envisages that physical cost of work of respondents while performing weeding activity manually ranges between 19- <20 beats /min. for all the three year where as it was almost half if done by conoweeder.

Energy expenditure for manual weeding was more than 10.5 Kj/min every year while by conoweeder it reduces up to 7.5 $\pm$ 1.5 Kj/min. As per Varghese classification of physiological work load weeding paddy crop manually is a heavy work but it is light if done with conoweeder. Results of the study are in concurrence with Deshmukh (2012).

Table 3: Ergonomic Assessment of the Conoweeder against Manual Weeding

| S. No.	Parameters	2015		2016		2017		Average	
		Manual	Conoweeder	Manual	Conoweeder	Manual	Conoweeder	Manual	Conoweeder
1	Physiological Cost of Work (Beats/min)	20.37	10.78	19.10	10.04	20.01	10.27	19.83	10.36
2	Energy Expenditure (Kj/min)	10.84	7.65	10.58	7.34	11.09	7.50	10.82	7.50
3	Classification of physiological work load	Heavy	Moderately heavy	Heavy	Light	Heavy	Light	Heavy	Light
4	Percent Change in Grip Strength								
A	Left hand	17.50	11.23	15.04	9.77	14.93	10.00	15.82	10.33
B	Right Hand	30.18	13.12	29.17	12.75	26.58	11.50	28.64	12.50
C	Both Hands	18.67	12.37	16.10	11.07	17.39	11.68	17.40	11.71
5	Economic Analysis								
A	Area Covered / hr/ m^2	3.10 m^2	9.32m^2	2.60 m^2	8.64 m^2	2.92 m^2	9.72 m^2	2.87 m^2	9.23 m^2
B	Weeding in one ha. (No. of man days)	26	8.6	24	7.2	27	8.1	25.67	8.00
C	Expenditure (labour Cost or wages) @ Rs 150/day	Rs.3900	Rs.1290	Rs.3600	Rs. 1080	Rs.4050	Rs. 1215	Rs.3850	Rs. 1195
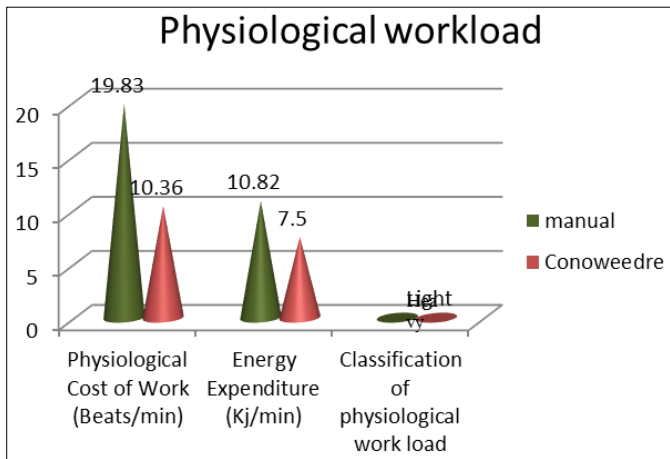
Fig 2: Average Physiological Workload while performing While Weeeding Activty of Last three years
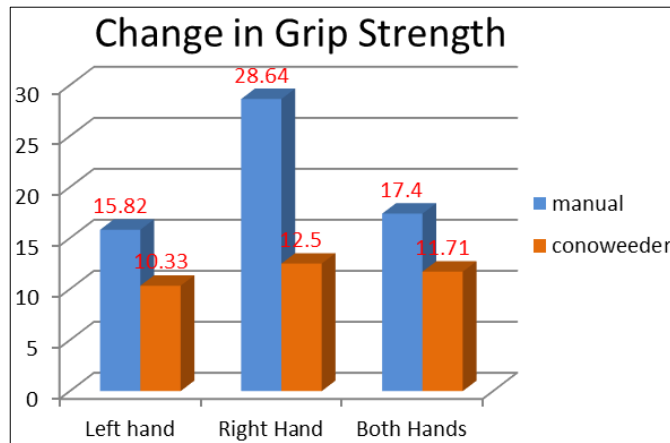

Fig 3: Average Percent Change in Grip Stranth Performimg Paddy Weeding Activitys of Last Three years
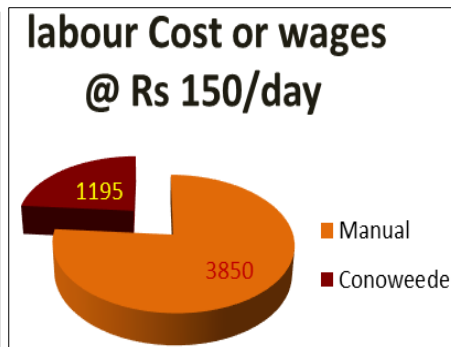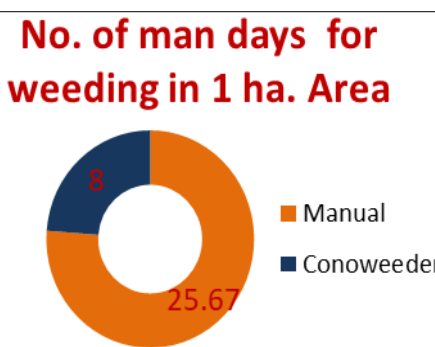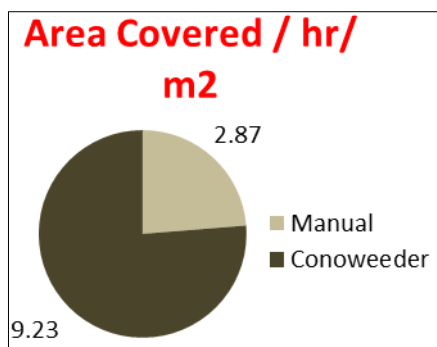

Fig 4, 5, 6: Economic Analysis of Conoweeder of Last Three Years

Percent Change in Grip Strength

According to table 3. huge reduction in grip strength was observed while performing paddy weeding manually in but in contrast it is quite less if done through conoweeder. From 14.93 to 17.50 percent reduction was found in left hand in all three years of study while in right hand it was 30.18 %, 29.17% and 26.58 % in the year2015,2016 and2017 respectively. In both the hands up to about 19.00 percent from 16.10 percent reduction was recorded in study period. On the other hand maximum 11.23 percent reduction in 2015 was observed in left hand while doing weeding with conoweeder. In right hand 13.12 percent reduction was recorded in 2015 while it was 12.75 and 11.50 in 2016 and 2017 respectively while performing weeding by the use of conoweeder and for both the hands it was also less a compared to manual. Factors which contribute to reduction in grip strength are mainly type of tool used, its material and width of handle etc. but in case of conoweeder it's a gender friendly tool so did not put much stress on hands.

Economics Analysis: Area covered manually was almost 1/3rd of the area covered through conoweeder in one hour. On an average 25 ± 2 man days needed to perform manual weeding in one hectare area but in case of conoweeder it is only 8-9 man days. If calculate expenditure in terms of wage paid as per current local wage rates of Kanpur Rs. 3900, 3600and 4050 @ 150/day in 2015,2016 and 2017 respectively but it is quite less in case of conoweeder Figure 2 is representing of average physiological work load of weeding activity of complete period of study in comparative form. It is very clearly depicted in figure that physiological cost of work is very less for conoweeder as compared to manual and same is with energy expenditure. Therefore activity is categorized as light activity in case of conoweeder with comparison to manual it is heavy. Figure-3 Average reduction in grip strength in all the three years was quite high for left, right and both the hands for manual weeding against conoweeder. In figure-3,4and 5 it is very clearly depicted that conoweeder is quite efficient tool in monitory terms. It took only 8 man days to perform weeding with conoweeder so wage is also less in compression to manual it was 25.67 man days and so as to wages also. Results of the study are in agreement to Nag (2011) [4] according to him about 15% of human labour is spent in removing weeds.

Table 4: Mean Distribution of Musculoskeletal Discomfort Reported in Different Body Parts while performing weeding Activity N=36 each year

S. No.	Body Part	2015		2016		2017	
		Manual	Conoweeder	Manual	Conoweeder	Manual	Conoweeder
1	Neck	2.58	1.16	2.37	1.19	2.56	1.22
2	Shoulder	2.29	1.85	2.11	2.00	2.62	1.90
3	Upper back	3.23	1.26	2.95	1.36	3.25	1.46
4	Lower back	4.08	2.11	3.42	2.86	3.60	2.60
5	Wrist	3.54	1.24	2.54	1.28	2.99	1.50

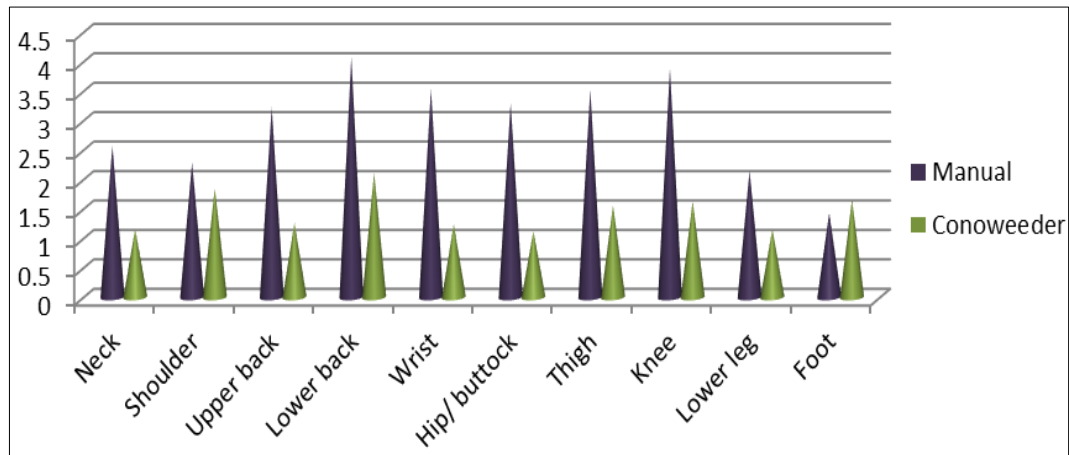| 6 | Hip/ buttock | 3.30 | 1.12 | 2.79 | 1.30 | 2.58 | 1.50 |
7	Thigh	3.53	1.56	2.70	1.69	2.74	1.66
8	Knee	3.89	1.63	3.37	1.72	2.98	1.81
9	Lower leg	2.15	1.16	2.07	1.26	2.26	1.20
10	Foot	1.43	1.66	1.89	1.73	1.83	1.80

Fig 7: Average Musculoskeletal Discomfort Reported in Last Three Years

Musculoskeletal Discomfort while Performing Weeding activity: Musculoskeletal discomforts are the pain or any kind of disco fort as a result of performing any activity in any body part. Data in Table-4 and Figure- 6 states that maximum discomfort was reported in lower back, upper back, knee, Wrist, thigh Neck, thighs and hip / buttocks. Since weeding is done in stooping posture pressure on upper and lower back, knee and neck is maximum while to carry out activity khurpi is used which exerts drudgery in wrist and shoulder. Conoweeder is a gender friendly weeding tool and through conoweeder weeding is done in standing posture so discomfort reported were less. Weeding is performed in squatting posture and respondent move backward and forward in this position with hands tensed to perform weeding, moderate to very severe pain was reported in lower back, upper back, knees, thighs, hips and wrist. Neck shoulder lower leg and feet are also in risk due to having very mild to severe pain. Findings are in concurrence with Goswami *et al* (2012) [3] and (Bridger 2008).

Conclusion
It can be concluded that majority of farm women were between 25-35 years age group illiterate, family's monthly income was less than10,000/month, belonged to nuclear family, having 5-7 Majority were representing good physical state. Weeding is a strenuous activity as it is heavy activity according to Varghese (1994) [7] classification , physiological cost and energy expenditure are quite high and Moderate to very severe pain was reported in lower back, upper back, neck, shoulder, knee, and wrists if done manually. Physiological work load of a worker can greatly be reduced by the use conoweeder for wet land paddy crop, physiological cost of work and energy expenditure of respondents were 10.36 beats /min and 7.50Kj/min respectively against 19.83 and 10.82 respectively if done manually. Reduction in grip strength was also quite less with conoweeder in comparison to manual. Cost of cultivation and time can be curtail by the use of improved agricultural tool. To ensure better health and safety, and to improve work efficiency and to reduce the drudgery of women as well, it is an important to have an understanding of the occupational work load of farm women by studying the efficiency and power of their muscles, heart, energy expenditure, their fatigability. The only solution to reduce drudgery in agriculture is introduction of improved gender friendly tool, make them easily available. It is therefore too suggested to train farmwomen about ergonomic, improved tools and technologies to enhance productivity.

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