CRIDA Wheel Hoe Intervention for Reducing Drudgery in Vegetable Crops Inter-cultivation

Abstract:

In agriculture, women are typically employed in labor-intensive, mostly mechanized processes that require a lot of drudgery.As part of KVK, Darsi's Front Line Demonstration (FLD) programme, farm women in adopted villages in the Prakasam District of Andhra Pradesh participated in an inter-cultivation study on vegetable crops (Chilli, Tomato and Okra) using CRIDA wheel hoes during the years 2019-20 and 2020-21 in comparison with the traditional weeding using hand hoe.It was clearly depicted that CRIDA wheel hoe hasproved efficient on time and output as compared with traditional hand hoe.CRIDA wheel hoe resulted in a higher output capacity of 116.3 m^2/hr as opposed to only 62.6 m^2/hr with a regular hoe.For CRIDA wheel hoe, the percentage increase in output was 85.78 %.In comparison to the traditional hand hoe method, labour wages per acre were reduced to Rs. 1700, weeding time per acre was shortened from 8.5 hours to 5.5 hours, overall pain rate decreased from 8.1 to 3.1, and musculoskeletal problems (MSP) decreased from high to low. CRIDA wheel hoe recorded drudgery index score of 56. Whereas, in traditional practice (hand hoe) maximum drudgery with drudgery index scoreof 81 was observed.

Key words:CRIDA wheel hoe, Drudgery, Efficiency of women in agriculture, ErgonomicsPosture, Weeding efficiency, Working efficiency.

Introduction:

In India, 70% of the population depends mostly on agriculture for their living. One of the unorganised sector's most labor-intensive jobs is agriculture.In India, the unorganised sector employs 93% of the labour force, which is associated with worse health and stress levels (Ratnam, 2016).Farm women utilise traditional hand tools like a spade and hand hoe to perform weeding tasks. Agricultural labour often goes unnoticed due to its high workloads, arduous labour, and negative health effects.Additionally, automated weeders that simultaneously conduct the tasks of weeding and hoeing can be used to accomplish timely weeding. This will cut down on the time, expense, and labor-intensive nature of manual weeding (Goel*et al.,* 2008) but

Comment [A1]: The title indicated more emphasis on drudgery reduction only. But the article stressed effect of CRIDA hoe on other factors/parameter other than drudgery. Therefore, it is suggested that the title is reviewed to accommodate other parameters as discussed in the article.

Suggest the title is changed to:
Comparative Performance Analysis of CRIDA Wheel Hoe and Traditional Hand Hoe in Vegetable Crops Inter-cultivation.

Comment [A2]: Good abstract.
please kindly add a simple summary of method of data collection and analysis.

Comment [A3]: Replace with "farm women"

Comment [A4]: You mean Agricultural sector? if yes kindly replace this with "agriculture sector"

manually operated weeders have foundacceptability due to their low cost (Beheraand Swain, 2005).

Numerous factors, such as regional differences in the nature of work, the socioeconomic status of farm families, family traditions, the mechanization of agricultural activities, the introduction of labour- and time-saving implements, and variations in agro--climatic conditions, all have an impact on farm women engaged in agricultural activities. It was noted that over 75% of women work in field farm operations performing tasks including grading, threshing, winnowing, weeding and cleaning (Singh and Vinay, 2013).Farm women must sit to complete this procedure, which adds drudgery and causes weariness and back strain.Women's percentage shares as domestic industry workers, agricultural labourers, cultivators, and other workers were 24.92, 18.56, 2.95, and 47.20, respectively (Prakash *et al*, 2014).They assume bending and crouching postures during these activities, which raises their physiological strain and exposes them to a variety of musculoskeletal issues, which significantly reduces women's productivity at work.

The workers using the weeder also have an impact on its performance in addition to its construction aspects. If the ergonomics of a man-implement system are not taken into consideration, it could function poorly.Additionally, it could result in anatomical or clinical abnormalities and harm employees' health. In addition to improving system efficiency, giving ergonomics due consideration during design and operation will protect the health of the workforce (Gite, 1997).The scientific study of ergonomics examines how people interact with their working environments, which include the surrounding air, equipment, materials, work practices, and organizational structures.The criteria of decreased energy consumption, stress, burden, time spent, physical ailments, exhaustion, and drudgery should be met by these technologies, which will improve agricultural workers' productivity, efficiency, income, and quality of products. As a result, technologies that are suitable for farmers' needs must be developed.The purpose of this research is to introduce wheel hoe developed by CRIDA, which will lessen their labour and boost their working efficiency. Farm women are required to perform manual labour, which entails significant exhaustion in addition to potential health risks. The CRIDA wheel hoe weighs less than the locally accessible tool, and the posture used during the operation is similarly improper and unhealthy for the worker. Women use this tool more quickly,posing comfortably while working is an additional benefit.In order to lessen worker

Comment [A5]: provide the full meaning of CRIDA since it is firstly mentioned.

tiredness, the effectiveness of enhanced agricultural technologies in comparison to old ways was also investigated in the farmer's field. Additionally, the ergonomic aspects of several improved agricultural technologies were tested.

Materials and Methods:

In the years 2019–20 and 2020–21, KVK, Darsi, Prakasam (Dt.), ANGRAU, Andhra Pradesh, performed a FLD programme with farm women in adopted villages (Chalivendram, Bodhanumpadu, Dhandubaigudem, Botlapalem). Farm women range in age from 22 to 48 and are physically normal.Numerous characteristics, including the temporal profile and physiological stress, were examined throughout the trial. The drudgery for inter-cultivation in vegetable crops was assessed using a comparative study using better technology, using conventional hand hoe and CRIDA wheel hoe. A meticulously designed interview questionnaire was utilized to gather the data, with particular focus on the chosen sample size's physical health and the likelihood of any significant health risks.

The CRIDA wheel hoe is a manually operated weeder. It is made up of a wheel frame, and wheel hoes were commonly used as weeding and intercultural tools in row crops. These are long-handled tools that are pulled and pushed.A wheel hoe is a manually powered tool used in intercultural operations and weeding. It has a handle, wheels, a frame, a v-blade, and a v clamp. Push and pull techniques are used in fields to trim and uproot weeds. It is lightweight and easy to use, which helps women workers with their posture at work and lessens their daily hardship. For best results, this is used when the soil moisture content is at its ideal level, ideally 20 to 25 days after planting when the weeds have grown to a height of only 1 to 3 cm (Singh*et al.*, 2007).

One of the key resources for the development of agriculture is the health of farm women. Therefore, in order to prevent health risks among farm women, steps to reduce drudgery must be implemented. Farm women's quality of life would undoubtedly improve if suitable drudgery reduction technologies were made available to them at home and on the farm. This would also increase their job capacity and decrease their amount of drudgery (Swarna*et al.*, 2018).Anthropometric measurements were taken, and using Garrow's (1987) classification of body mass index (BMI), the health status of women was determined. The following criteria are used to calculate the implement's efficiency when compared to a farmer's hand hoe or other farming method.Efficiency of theimplement in comparison to hand hoe or farmers practice is calculated as per thefollowing parameters.

Comment [A6]: please move this to proper place in material and methods section. otherwise, kindly delete it.

Comment [A7]: please kindly reorganized section
a. state out clearly the materials used for the research including the equipments CRIDA, hand hold, and other instrumentation adopted in data collection and the evaluation
b. state out the following;
(i) method of data collection (Questionnaire)
. . state clearly all the important parameters captured in the questionnaire.
(ii) method of analysis or comparisons adopted
. (iii) parameters considered for performance comparisons
(iv) present the picture of both equipments – CRIDA and hand hoe.

Comment [A8]: correct this
2019 – 2020 and 2020 - 2021

Weeding Index Percent:The amount of weeds that a particular weeder can remove in a given amount of time is known as its weeding efficiency. The formula below is used to calculate it.E={(w1-w2)/w1}x100, Where, e= weeding index, w1= Number of weeds/m2 before weeding, w2= Number of weeds/m2 after weeding.

Drudgery Index:Farm women's experiences with physical and mental strain, exhaustion, repetition, and misery during weeding operations were operationalized as drudgery.

DI score between 70 and above = Maximum drudgery
DI score between 50 and 70 = Moderate drudgery
DI score between 50 and below = Minimum drudgery

Overall Discomfort Rate:A 10-point psychophysical rating scale (0 being no discomfort and 10 being great discomfort) was used to calculate the overall discomfort rate, following the methodology of Corlett and Bishop (1976). On the scale, there was a sliding pointer to indicate the degree of discomfort. Subjects were asked to rate their overall level of pain on a scale at the conclusion of each trial. The mean rating was calculated by averaging the ratings.

Musculo skeletal Problems: The reason nearly all of the women claimed that their productivity was significantly decreased as a result of working in a crouching posture for extended periods of time could be the cause. The assessment of musculoskeletal issues and postural issues involved asking the participants where they experienced pain during or after the weeding process.A five-point rating system was employed to document the level of pain in each body part: 5, 4, 3, 2, and I denoting very severe, severe, moderate, mild, and very mild, respectively.

The heart rate monitoring device was connected to each respondent and turned on to record the heart rate per minute. Five minutes of rest were required to record the resting heart rate. After 30 minutes of the exercise, they were instructed to record their heart rates every minute. Following this, they were given five minutes of rest. After being turned off, the heart rate monitor was taken out. Heart rates were measured while using a CRIDA wheel hoe and a traditional hand hoe at rest and during work. The heart rate recordings were used to derive the recorded parameters.For calculation of Energy Expenditure Rate fromheart rate, the Varghese (1994) equation was usedwhich is as follows.

EER (kj/min) = 0.159 X HR (beats/min) – 8.72.

Results and Discussion:

Comment [A9]: kindly specify, which of the following is of interest
- weeding index
- weeding index percent or
- weeding efficiency

Based on definition presented, suggest you select weeding efficiency

Comment [A10]: By standard, kindly use equation editor for all the equation presented in the manuscript.

All the equation and definition must be properly acknowledged with their respective sources and author.

Kindly present the equations according to journal specified standard.

Comment [A11]: Add this…
Therefore, according to (add sources of D1 – D3), drudgery is defined and grouped as follows.
D1……..
D2……..
D3……..

Comment [A12]: Follow standard equation editor format and define all the terms.

Physical attributes of the participants depicted in Table 1 displays the subjects' basic anthropometric information. The selected farm women had a mean age of 34.5 years, an average height of 164.60 cm, and a gross body weight that ranged from 50 to 82 kg with the average weight of 61.5, as indicated in the table. Their computed mean BMI of 24.50 indicated that they fell within the normal range.

Comment [A13]: provide heading for this e.g Subject Physical Characteristics

Table 1. Physical Characteristics of the respondents (N=60)

Physical Characteristics	Range	Mean
Age in years	22-48	34.5
Height (cm)	140-186	164.6
Weight (kg)	50-82	61.5
Body mass Index	19.3-27.4	24.5

Comment [A14]: make a clear heading e.g Farm women operational participation

Extent of participation of farm women in agricultural operations: It is evident from the table 2 that the extent of participation by the majority of the farm women in agricultural operations was medium (70.00 %),followed by high (16.67 %) and low (13.33 %). The findings were inconformity with conclusions of Bhairve (2013) and KajalKumari Chauhan *et al*., (2019)which details the extent of women's participation in agricultural activities.Similarly, Chinnam Naidu*et al*. (2020) also revealed that the higher percentage (67.50%) of the farm women were medium extent of participation in agricultural activities.

Comment [A15]: please check this, incomformity or in comformity?

Comment [A16]: double check for proper citing and abbreviation

Table 2. Distribution of farm women according to extent of participation in different agricultural operations (N=60)

Categories	Frequency	Percentage
Low	8	13.33
Medium	42	70.00
High	10	16.67
Total	**60**	**100**

The data analysis (Table 3) shows that using the CRIDA wheel hoe results in changes to both the proportion of average working heart rate and energy consumption. When compared to a traditional hoe, the CRIDA wheel hoe has demonstrated efficiency in terms of time and output characteristics, as seen by its increased production. With the operation of the CRIDA wheel hoe, the average working heart rate changed by 12.52 percent. An identical pattern was noted for the mean energy use as well.The results in table 3 indicated that improved technology has significantlyhigher work output than the traditional technology. Because all other factors were

kept constant, it is possible to relate the variation in the weeder's heart rate and oxygen consumption to its design configurations (Thiyagarahan, *et. al.,* 2012). Similarly, as all other parameters were kept constant, our results further supported Singh (2010) and Singh *et al.* (2011)'s findings that the weeder's design configurations may be to blame for variations in heart rate and oxygen consumption (Sharma *et al.,* 2015).

The amount of work produced by the weeding operation using both conventional and advanced technologies were compared. The production of improved technologies is far higher than that of traditional technology. The CRIDA wheel hoe weeder showed the greatest increase in work output.Using a CRIDA wheel hoe resulted in a higher output capacity of 116.3 m^2/hr as opposed to only 62.6 m^2/hr with a regular hoe.The productivity of improved technologies is far higher than that of traditional ones. For CRIDA wheel hoe, the percentage increase in output was 85.78 %. When compared to traditional implements, the work production was almost twice as high, hence using a CRIDA wheel hoe is advised. Therefore, the goal of this study is to provide farm women with better tools for weeding so they can work more productively, be more efficient, and experience less drudgery in the process.The average heart rate (HR) while using a traditional hoe for intercultural activities was 107.8 beats per minute. The recorded rate when using the CRIDA wheel hoe was 121.3 beats per minute. It was determined that 8.3 kJ/min was the energy expenditure during inter-cultivation in vegetable crops, for which it is responsible. conventional methods, whereas the dual wheel hoe reported 11.3 kJ/min and improves efficiency.Similarly results were reported by Tripathi*et al.* (2016) that twin wheel hoe hasproved efficient on time and output as compared with traditional Khurpi.

Table 3. Machine and ergonomic parameters comparison of hand hoe and CRIDA wheel hoe (N=60)

Parameters	**Hand hoe**	**CRIDA wheel hoe**	**% change over**
Machine parameters			
Output (m2/ha)	62.6	116.3	↑85.78
Weeding efficiency (%)	68.5	62.7	↓8.47
Stroke/min	52.6	41.3	↓21.48
Ergonomic parameters			
Avg. resting heart rate (b/min)	79.6	83.7	↑5.15
Avg. working heart rate (b/min)	107.8	121.3	↑12.52
Avg. energy expenditure working (kj/min)	8.3	11.3	↑36.14
Increase in efficiency (%)			

Total cardiac cost of work (TCCW)	381.8	228.7	↓40.10
Physiological cost of work (PCW)	8.7	4.33	↓50.23

Comment [A18]: Please note that, you did not present a procedure on cardiac cost of work and physiological cost of work.

The data from the table 4 of field studies indicated that the mean number of labour employed using the traditional hand hoe was 10 in one acre. Whereas, using the CRIDA wheel hoe mean number of labour required was 5 per acre. Average labour wages per acre using the traditional wheel hoe was 3150 and in CRIDA wheel hoe it was 1450, with a difference of -1700.Weeding in vegetables is an activity where musculo-skeletal problems are verypronounced. The reason is that weeding takes a lot of time and requires continuous, lengthy hours of work. The conventional approach uses a hand hoe and a constant sitting position to weed. According to Table 4, the hand hoe and CRIDA wheel hoe had overall pain rates of 8.1 and 3.1, respectively, which is higher than moderate and light discomfort.Additionally, three CRIDA wheel hoes required less time (5.5 hours) to complete one acre of weeding than a hand hoe (8.5 hours). Nonetheless, the hand hoe method's weeding effectiveness was found to be good (89.95%), and the three-pronged wheel hoe method was determined to be more technically and economically viable overall than the conventional hand hoe method. The results are in close conformity with Sudha Rani *et al.* (2020).

By asking the respondents where they felt pain in their bodies after using both traditional and enhanced technologies, the musculoskeletal issues and posture were assessed. The data (Table 4) show that using typical equipment to weed while adopting an awkward posture results in excruciating pain in the hands, knees, shoulders, and mid-back. The women thought the assignment was difficult. Conversely, the use of the upgraded weeding tool caused moderate to mild soreness and discomfort in the arms, hands, and shoulders.Our findings also align with those of Sharma *et al.* (2015), who established a positive correlation between energy expenditure and heart rate rise. They also found that, when using a traditional hoe to weed soybean crops, more musculoskeletal joint pain was experienced at the same energy expenditure point as when using a twin wheel hoe.

The drudgery index of weeding with handhoe and CRIDA wheel hoe was determined bycalculating the time co-efficient, frequency ofperformance coefficient and difficulty coefficient.By using this CRIDA wheel hoe, moderatedrudgery (drudgery index score 56) was recorded. Whereas, in traditional practice (hand hoe) maximumdrudgery (drudgery index score 81) was recorded.According to this study, ergonomic design and a woman-friendly design for

work tools are crucial for ensuring health, safety, and well-being, which in turn improves work-life balance and boosts productivity. It was determined that the three-tyne wheel hoe's weeding effectiveness was adequate. Because it improved job efficiency, decreased drudgery, and offered a comfortable working posture, it was a tool that was beneficial to women.

Conclusion:

The CRIDA wheel hoe was found to have a lower physiological cost than the conventional method. It was discovered to be the most effective method for weeding vegetable fields and to be compatible, manageable, and appropriate in yield situations. It was found that the CRIDA wheel hoe was helpful in reducing labour costs, time, and effort while boosting output. It was noted that using a weederenhanced the worker's efficiency and posture. Because using a weeder required standing posture, which eliminated muscular tiredness and excessive stress of the backbone's intervertebral discs, the discomfort in the body decreased. This shown that weeders were more efficient workers, pleasant to women, and reduced drudgery. Therefore, encouraging farm women to use these technologies in their agricultural operations should be a top focus.

Comment [A19]: Using a weeder like CRIDA, enhanced…….

Comment [A20]: Efficiently used by the workers

Comment [A21]: The recommendation of the research should also be presented.

Table 4. Performance between CRIDA wheel hoe and hand hoe in field conditions in different cultivated crops (N=30)

Parameters	Hand hoe		CRIDA wheel hoe		Mean		Difference	t-value
	2019-20	2020-21	2019-20	2020-21	Hand hoe	CRIDA wheel hoe		
Work done area (Acre)	1.0	1.0	1.0	1.0	1.0	1.0	--	--
Labour employed (No.)	9	11	5	4	10	5	-5	5.87**
Labour wages (Rs/-)	2700	3600	1700	1200	3150	1450	-1700	8.28**
Time taken for weeding (hr)	9	8	5	6	8.5	5.5	-3	-3.35*
Weeding efficiency (%)	88.6	91.3	79.6	81.3	89.95	80.45	-9.5	11.5**
Overall discomfort rate (ODR)	8.2	8	3.3	3	8.1	3.1	-5	3.63**
Drudgery Index (DI)	83.3	78.7	54.3	57.7	81	56	--	--
Musculo-skeletal problem (MSP)	Very severe to severe pain experienced		Moderate to mild pain		--	--	--	--

Comment [A22]: Obviously, table 4 shows the result of experiment at N = 30. Though the "N" is not define. please kindly define it at the above table 3.

Why do you think the table is necessary for presentation here since the above table 3 showed results for N = 60?

Suggest table 4 is removed.

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Comment [A23]: All cited references should be written in full and follows the journal prescribe method of referencing.

Comment [A24]: Remove, this is not cited.

Comment [A25]: Chinnam, N, D., Bhagya, L, K and Roy, G, S. corlett

Comment [A26]: write in full

Comment [A27]: agriculutural

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