All India Coordinated Research Project on Ergonomics and Safety in Agriculture
ICAR- Central Institute for Women in Agriculture centre

Section - I

GENERAL INFORMATION

1.	Title of the scheme	:	All India Coordinated Research Project on Ergonomics and Safety in Agriculture(AICRP on ESA)
2.	Location of the scheme	:	ICAR-CIWA, Bhubaneswar
3.	ICAR sanction No	:	F.No. 2(7)/2017-PIM dated October 13, 2017 page 46, ADG (PI&M)
4.	Mandate of Scheme	:	Application of ergonomical principles and anthropometric data for increasing productivity, reducing drudgery, and minimizing accidents and occupational health problems of workers in agriculture and allied sectors.

A. List of Personnel

1. Er. Chaitrali Shashank Mhatre (PI)
2. Dr. Jyoti Nayak (Co-PI)
3. Er. Pragati Kishore Rout (TA)
4. Er. Gayatri Mohanty (SRF)

B. Budget Information

Table 1. Expenditure statement up to October *(in lakhs)*

Sl. No	Head	Budget Estimate	Funds Received as on 30/09/2018	Progressive expenditure up to 30/092018	C.B as per fund received
1	2	3	4	5	6 (4-5)
1	Esst. Charges (salary)	0	0	0	0
2	Travelling allowance	130000	75000	0	75000
3	Research Expenses	600000	300000	128993	171007
4	Equipments	200000	150000	0	150000
		930000	**525000**	**128993**	**396007**

C. List of on-going projects

Table . 2 Particulars of the ongoing projects

Name of the project	Date of start
Design and development of multipurpose harvesting bag for easy loading and unloading	**July, 2018**
Empowerment of women through socio technological interventions in mechanization	**July, 2018**
Design and Development of Women friendly power operated groundnut decorticator	**July, 2018**

Section-II

PROJECT 1: DESIGN AND DEVELOPMENT OF MULTIPURPOSE HARVESTING BAG FOR EASY LOADING AND UNLOADING

A. INTRODUCTION:

Harvesting is the operation of cutting, picking, plucking, digging or a combination of these operations for removing the crop from under the ground or removing the useful part or fruits from plant. Harvesting can be classified into two categories viz. Hand picking / harvesting and Mechanical harvesting. Machine harvesting not only saves time but also reduces the quantity of waste to a great extent and reduces drudgery, injuries and operation time. But in Indian conditions, especially on marginal to medium level of farm / orchards still hand picking methods are prevalent. Various postures are adopted while harvesting variety of fruit crops and vegetables. They are as described as below:

Tree crops (guava, apples, oranges, pears, etc.) require overhead reaches, awkward postures of the low back when picking, high low back loads when carrying buckets of produce, ascending and descending ladders, hazards when climbing the trees.

Ground crops (cucumbers, sweet potatoes, melons, etc.) require static squatting or bending postures of the low back, kneeling postures and heavy lifting from ground level when lifting the buckets of produce.

Bush and vine crops (peppers, tomatoes etc.) require static bending postures, lateral bending of the torso, kneeling postures, squatting postures and heavy lifting of the buckets of produce from ground level.

Furthermore the produce also has to be carried from the picking point to the collection point over and over as the picked produce fills the person's hand. This causes the repetitive cycle of the harvesting posture and walking and bending posture (to drop the produce in the collection crate). For example in case of

Ground crops: Squatting- getting up while lifting the load- walking with load - bending to drop the load - walking back

Tree crops: Reaching- walking with load - bending to drop the load - walking back

Bush crops: Bending- standing upright with load - walking with load- bending to drop load - walking back

Regardless of the crops being harvested, the development of ergonomic solutions for these tasks is made difficult by the dynamic and natural environment in which this work is performed.

Muscoskeletal loading:

As per above observation reaching, bending and squatting posture are commonly adopted during harvesting operation. If the time required to harvest and transport the harvest to crate is reduced, it will effectively reduce the drudgery caused due to these activities.

After complete harvesting, crate of the produce is lifted on the head and carried to the sale spot, further it is lowered carefully from the over head height to the ground height in a bending or squatting posture.

The lifting of the heavy load (approximately 14 kg per crate) will exert extreme bending stress on the lower back region. The L5/S1 vertebrae to be specific will be loaded. The neck region (cervical vertebrae) and upper back (thoracic vertebrae) will be under compression stress due to placing of load on the head while walking. Further, while unloading the harvest, the crate has to be lowered. For this while still in standing posture, subject has to lift the load off the head then lean slightly backwards while bringing the load downwards and in front of them, followed by either bending or squatting posture to place the load on the ground. During this process the entire spinal cord will be under various stresses. Hence a multipurpose harvesting bag was designed and developed to mitigate these problems. The bag will aim to reduce the time of harvest and also the correct postural issues occurring during the loading and unloading of harvest.

B. DESIGN OF HARVEST BAG

The proposed bag is to be made gender friendly, hence the appropriate anthropometric dimensions of Indian male and female agricultural workers is taken in to consideration. The design is as follows:

1) Height of the bag:

A) Working height:

The bag must be below the waist so as to accommodate the harvested fruits and vegetables, but above the knees for free movement of the worker while harvesting.

Illiocrystale height: 831mm (5th percentile, Indian agricultural female labour)

Knee height: 388 mm (5th percentile, Indian agricultural female labour)

Hence the maximum working height is:

831 - 388 = 443 mm ≈ **440 mm**

B) Unloading height:

As the Illiocrystale height is 831 mm hence the unloading height is kept **700 mm** for easy unloading in the crates kept on the ground

Hence the fold length is

700 - 440 = **260 mm**

2) Width of the bag:

Waist breadth: 217 mm ≈ **200 mm**

4) Shoulder strap length:

Table 3. Anthropometric parameters required for desiging shoulder strap

Anthropometric parameter	**95 % male**	**5 % female**
Waist back length (mm)	520	315
Scapula to waist back length (mm)	730	445
Total	**1250**	**760**

Hence the total length of shoulder strap is 1300 mm with continuous adjustment.

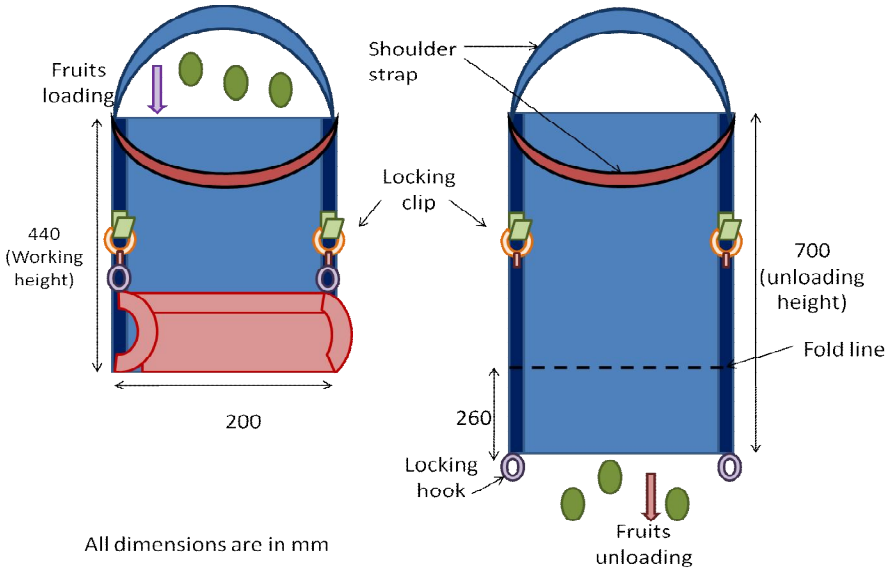


Fig.1 Harvest bag for drudgery reduction in harvesting, lifting and transferring of the fruits and vegetables

The overall dimensions of the bag are tabulated below:

Table . 4 Dimensions of the harvest bag

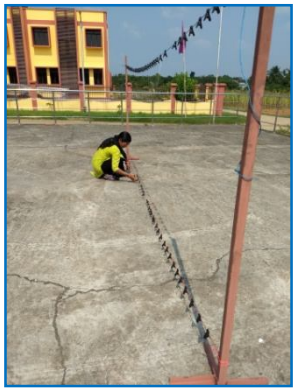
Sl. No.	Particulars	Dimension (mm)
1	Working height	440
2	Unloading height	700
3	Width of the bag	200
5	Shoulder strap length	1300

C. ANALYSIS OF POSTURES ADOPTED WHILE HARVESTING, AND UNLOADING FRUITS/VEGETABLES USING REBA, RULA AND BIOMECHANICAL STUDY:

C.1 REBA and RULA

RULA and REBA technique was used to quantify the drudgery that was caused due the harvest postures such as reaching, standing, bending and squatting the results are tabulated below:

Table 5. Postures adopted while harvesting

				
Overhead, reaching		standing	Bending	squatting
RULA	7	6	7	7
REBA	6	4	11	11

The inference for RULA and REBA analysis for all the postures ranges from medium risk to high risk.

Unloading is one of the drudgery prone activities during the harvesting operation. It not only causes drudgery but also may lead to hazards such as falling due to imbalance. It may also cause muscoskeletal diseases and chronic neck and back pains. It was observed that Indian

female labor lower the crate using two end postures viz., squatting and bending. Hence analysis was done for these two postures.

Table 6. Postures adopted while unloading (end posture - squatting)

				
Lifting the load off the head		Bringing the load forward and downward while leaning backward	Lowering the load while bending the body through knees	Lowering the load in squatting posture
RULA	7	7	7	7
REBA	8	8	11	12

The inference for RULA and REBA analysis for all the postures ranges from High risk to very high risk

Table 7. Postures adopted while unloading (end posture - bending)

			
Lifting the load off the head		Bringing the load forward and downward while leaning backward	Lowering the load in bending posture
RULA	7	7	7
REBA	10	11	12

The inference for RULA and REBA analysis for all the postures ranges from High risk to very high risk. It suggests for immediate implementation of change.

Harvest bag was thus designed keeping in mind the ease of unloading. The analysis of the posture while using the bag was also done.

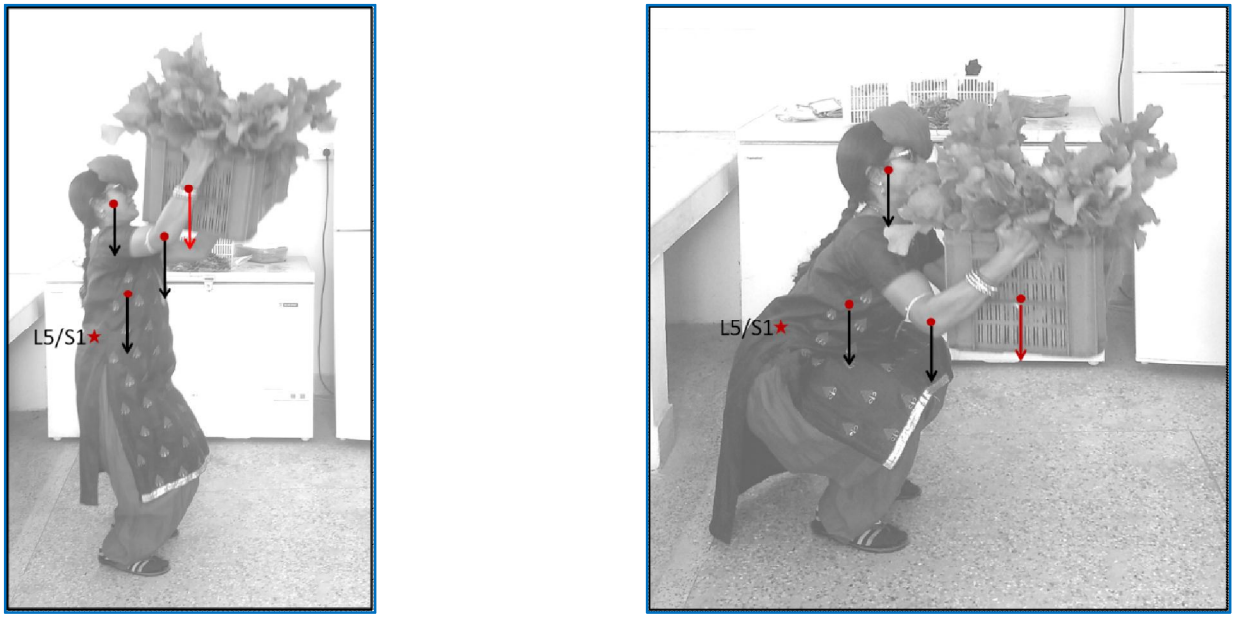
Table 8. Postures adopted while unloading using harvest bag

		
Harvest bag loaded		Harvest bag unloaded
RULA	4	4
REBA	2	2

Thus the bag reduced the RULA and REBA score significantly. This reduction is due to change of: arm position from the overhead position (> 90°), no twisting of wrist, neck and trunk is not in extension also the load is shifted from the head to shoulder.

C.2 Biomechanics of unloading operation:

Two stages of the operation i.e. start of the operation and end of the operation were chosen for the study so as to get the complete scenario of the operation.



a B

Fig 2. Load arms of the head, trunk, hand and external load in start and end of unloading operation

The weight of the selected subject is 53 kg. Segmental weights of head trunk and hands are calculated as per the percentage of whole body weights determined in the study (Relationship between segmental and whole body weights and volumes of Indians, G G Ray, 1981)

Table 9. Segmental weights of the body

Body parts	Segmental weights as percentage of whole body weight (%)	Actual weight (kg)
Head	8.89	4.71
Trunk	62.86	33.32
Hand	7.09	3.76
Leg	21.06	11.16

The balancing force is provided by the extensor muscle. And the instantaneous center of rotation (fulcrum) is located at L5/S1 vertebrae joint. The distance between the extensor muscle and L5S1 joint (effort arm) is 5 cm (Occupational Ergonomics, Amit Bhattacharya). The load

arms for head, trunk hand and external load is measure in a pictographic representation by using appropriate scale.

As it is a static biomechanical analysis the forces are assumed to be balanced. Thus the effort at the start of the unloading operation is **1653.35 N** and that at the end of the operation is **2829.17 N**

The biomechanical study of the posture adopted while the bag is fully loaded and is about to be unloaded is done

Fig 3. Load arms of the head, trunk, hand and harvest bag

The effort due the unloading by harvest bag is **1271.71 N**. The use of bag reduces the effort of the extensor muscle by 23.10 per cent (384.64 N) at the start of unloading and at the end of operation the reduction in effort is 55.1 per cent (1557.47 N). Thus the bag is reducing the effort required by the muscle and also reducing the force exerted on the L5/S1 joint.

D. TESTING OF THE BAG IN VARIOUS POSTURES FOR PHYSIOLOGICAL COST AND TIME UTILIZED:

Comparative performance evaluation of the bag was done with the existing harvest method. The experimental set up was designed to reduce variables which occur during the natural harvesting of the fruit/vegetable. These variables include density and bearing height of fruit/vegetable on plants.

D.1.Experimental set up:

The set was prepared whit the objective of replicating the four major posture that are adopted while performing the harvesting operation. It consisted of two angle iron bars of 183 cm (6 ft) separated by 2.6 m distance. The bar drilled with 4 pair of holes for tying ropes to replicate four postures i.e. squatting posture (15 cm), bending posture (15 cm), standing posture (86cm) and over head posture (150 cm) from ground level. Cloth drying pins (40 nos) were equidistantly clipped to the rope. These pins represented the fruits / vegetables to be harvested.

Fig.4 Experimental setup

D.2 Performance evaluation of the harvesting bag:

Seven subjects (4 female and 3 male) were chosen for the evaluation of the harvesting bag. The subject profile is tabulated in table 10. The test was done in four postures viz., reaching, standing, bending and squatting. The time required to pick all the clips from the rope was recorded in both cases. Corresponding heart rates were also recorded at the time. The design of the experiment is given in table 11.

Table 10. Details of the Subjects

Particulars	Female	Male
Age	32.7 ± 6.9	27.66 ± 3.2
Weight (kg)	55.25 ± 8.6	63.33 ± 16.6
Height (cm)	155.19 ± 10.66	169.78 ± 5.12
Vertical grip reach (cm)	178 ± 7.6	201.33 ± 16.28
Horizontal grip reach (cm)	69.62 ± 2.8	74.66 ± 5.03

Table 11. Design of experiment for the comparative performance evaluation of harvest bag with existing method

VARIABLES		LEVELS
Independent variables		
Harvesting practice	2	Existing method
		Using harvest bag
Postures	4	Over head reaching
		Standing
		Bending
		Squatting
Dependent variable:		
1. Picking capacity (Number of clips per hour)		
2. Work pulse (ΔHR)		

1. Picking capacity (Number of clips per hour)

The subject was asked to be positioned at the start point of the rope and asked to collect all the pins on the rope. The time require for the same was recorded. Three replications were taken for all the subjects. It was observed that when the subject worked without the bag she/he made 4 to 7 trips to the collection bin to drop the pins in them. This led to wastage of time. When the bag was provided to the subject this wastage of time was avoided. The particulars of the data are tabulated below:

Table 12. Comparison of the picking capacity with and without bag

Posture	Gender	Picking capacity (clips per hour)		Percentage change
		Without bag	With bag	
Over head reaching	Female	1610	2457	52.61
	Male	1530	2219	45.03
Standing	Female	1315	1933	47.00
	Male	1116	1311	17.47
Bending	Female	1910	2267	18.69
	Male	1634	2635	61.26
Squatting	Female	1910	2220	16.23
	Male	1634	3028	85.31

It can be observed that for both male and female the capacity of picking increases when the subject uses the developed harvesting bag. After statistical analysis (paired t-test) it was found that this increase is significant in case of females while insignificant for male subjects. This may be due to the fact that the percentage distribution of segmental weight for both upper and lower limb is lower in female than male. It applies for very fast and light repetitive tasks are usually done by females. (Segmental weights and volumes of Indians; G.G. Ray et.al; 1981). Further study is proposed to be done for exhaustive testing.

Overhead, reaching

Standing posture

Bending posture

Squatting posture

Fig.5 Performance evaluation of the harvest bag

2. Heart rate (bmp):

The subject was asked to rest before the test was conducted. The rest heart rate was recorded. After all the pins were collected the working heart rate was recorded. Work pulse was calculated subsequently. Ample rest was given to the subject between replications. The observations are tabulated below:

Table 13. Comparison of work pulse (ΔHR) with and without bag

Posture	Gender	ΔHR		Percentage change
		Without bag	With bag	
Over head reaching	Female	8	6.8	-15.00
	Male	17	13	-23.53
Standing	Female	16	11.6	-27.50
	Male	35	20	-42.86
Bending	Female	23	22.66	-1.45
	Male	32	18	-43.75
Squatting	Female	17.75	23.75	33.80
	Male	15.33	15.66	2.17

It can be observed that for both male and female the ΔHR decreases when the subject uses the developed harvesting bag for all postures except squatting. But after statistical analysis (paired t-test) this decrease was found to be insignificant. The observed decrease in ΔHR may be

due to the fact that while using harvest bag the subject makes no trips to unload the clips when hands become full. They simply drop the produce in the bag and carry on with the work. But as use of the bag does not alter any other parameter suck as the actual posture of the harvest the heart rate may not be significantly decreased. Further study is proposed to be done for exhaustive testing.

PROJECT 2: DESIGN AND DEVELOPMENT OF WOMEN FRIENDLY POWER OPERATED GROUNDNUT STRIPPER CUM DECORTICATOR

A. INTRODUCTION

Groundnut is the sixth most important oilseed crop in the world. It contains 46-50% oil and 25-28% protein, and is a rich source of dietary fiber, minerals and vitamins. It grows best on soils that are well drained, loosely textured and well supplied with calcium, potassium and phosphorous. Over 100 countries worldwide grow groundnut. Post harvest activities in the ground nut including stripping the pods from plants and then removing the kernel from the pod. For the decorticating operation, the existing manual decorticator is time consuming and drudgery prone (repetitive to-and -fro action). To reduce the drudgery and save the time by combining the *stripping* and *decortications* operation, the manual decorticator was proposed to be modified and make it power operated. The to and fro action (oscillatory motion) of the shoe was converted to rotary action. The existing decorticating drum and concave were additionally fitted with striping pegs. The process of designing the different parts of sheller-cum-decorticator done by considering operational parameters of machines, physical properties of ground nut and ergonomic factors of end users.

As this is modification over the existing standing type groundnut decorticator the dimensions of the concave are retained from the original design. Thus the stripper-cum-decorticating drum is designed as per the concave's dimensions. Stripping and decorticating shoe are arranged alternatively to provide balance. Motor of 0.5 hp is used for the operation. Attachment of blower for cleaning the kernel from pod is planned for future.

B. MEASUREMENT OF PHYSICAL PROPERTIES OF GROUNDNUT

The physical properties of groundnut that influenced the design of the machine were measured; they are the length and die of pod and kernel. Three parameters were determined as per the standard procedure with variation of moisture content from 7-25 % (db). Varieties of groundnut in Odisha are jawal. The observed values are tabulated below.

Table 14. Physical properties of Groundnut pods and kernel

Parameters		Pod	Kernel
Length (cm)	Maximum	2.8	1.5
	Minimum	1.6	0.6
	Average	2.2	1.09
Diameter (cm)	Maximum	1	**0.5**
	Minimum	**0.6**	0.2
	Average	0.87	0.39

C. CONSTRUCTIONAL DETAILS OF THE MACHINE

As this is modification over the existing standing type groundnut decorticator the dimensions of the concave are retained from the original design. Thus the stripper-cum-decorticating drum is designed as per the concave's dimensions. Stripping and decorticating shoe are arranged alternatively to provide balance. Motor of 0.5 hp is used for the operation. Attachment of blower for cleaning the kernel from pod is planned for future. The designed machine can work in two modes viz., only decorticating operation and combination of stripping cum decorticating operation as per requirement. Overall dimension of the machine is 92 cm x 62 cm x 62 cm.

1. Design of Stripping shoe

The stripping of the pods from the plant material was to be done by combing action. Combing action will ensure maximum number of pods separated from the plant material. The combing shoe was fitted with the pegs of height 4 cm. For stripping unit; pegs were selected over traditional saw teeth like unit as it will also provide some form of impact. This extra impact will help the decortications procedure as it will fracture the pod shell. Thus less force and energy will be required for actual cracking of the shell to release the kernel from the pod. The shoe has two racks carrying nine pegs each. The pegs are spaced 2 cm apart, but the pegs on the two racks are placed in staggered manner thus the effective spacing between them is 1 cm. This will ensure maximum removal of the pods from plant as the diameter of pod ranges from 0.6cm to 1 cm. One centimeter distance was chosen instead 0.6 so that less breakage will occur to kernels as the minimum diameter of the kernel is 0.5 cm. As there will be some root and plant material the

density of the pod, roots and stem together in the 1 cm gap between teeth will ensure maximum separation of the pod from the plant. Total numbers of strippers present in this machine are 4.

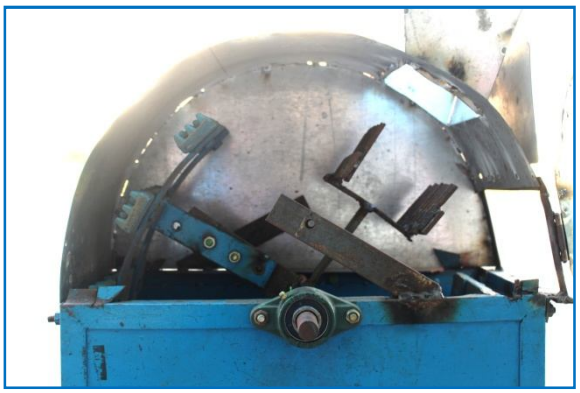
2. Design of the decorticating shoe

The existing decorticating dimensions shoe of the groundnut decorticator is used for the decorticating action. Three numbers of shoes in one limb is attached. Total numbers of shoes present in this machine are 6. There is a scope to adjust the clearance ranging 20-25 mm.

3. Design of hopper

The trapezoidal hopper which will be used for feeding groundnut pod when machine is being used for only decorticating operation. It has upper dimension is about 24 cm x 17 cm and lower dimension is about 18 cm x 10 cm. The total height of the hopper from the ground level is 93 cm.

Ground nut decorticator cum stripper



Arrangemet of Decorticating and Stripping shoes

Decorticating shoe

Stripping shoe

Operation of the machine

Seperated pods and kernels

Fig.6 Performance evaluation of Ground nut decorticator cum stripper

4. Design of feeding chute

The rectangular hold on type feeding chute is of dimension 24 cm x 11 cm. There is projection for hand support up to 12 cm. The height of the feeding chute is 50 cm from the ground level.

5. Power transmission

A 0.5 hp motor is used for powering the decorticating drum. The power is transmitted by v-belt and pulley. The rpm of the motor is 1425.

Diameter of the threshing drum was taken as per the availability concavity of the pre existing standing type decorticator.

$V\ (m/s) = (\pi x Dc x Nc)/60$

Where,

V- Velocity of threshing drum for groundnut (m/s) = 9 m/s (*Data book for agricultural machinery.)*

Nc- Speed of the threshing drum (rpm)

Dc- Diameter of the threshing drum (m) = 0.48 m

From the above formula and data it is calculated that the rpm of the threshing drum should be around 360 rpm. Hence the reduction ration is 1425:360::3.9:1 i.e. =4:1 . So, the rpm is reduced by using a 3:11 inch pulley. The rpm of the drum is around 368 considering 5% slip. The concavity of the available concave of the groundnut thresher is about 25 cm.

D. OPERATION OF THE MACHINE:

Pilot study was done for preliminary testing of machine. It was found that the pods are successfully getting separated from the plant material. But the all pods were not getting retained in the threshing drum. This may be due to the fact that there was comparatively less amount of pods in the drum and the peripheral velocity of the drum was also higher than needed. The pods that were retained were getting decorticated as expected, with 5-7 per cent breakage. Further modification to reduce the peripheral speed of the drum and to design the feeding chute for more safety is proposed in the future. Man-power requirement for operating the developed machine is one.

PROJECT 3: LEVEL OF MECHANIZATION AMONG RURAL FARM WOMEN: ASSESSMENT AND INTERVENTION

A. INTRODUCTION, GENESIS AND RATIONALE:

Women played a major role in decision making process in traditional agriculture, but they are virtually not recognized as producer within their right. Due to socio-cultural traditions, the rural women have subordinate role in the society. They have inaccessibility to modern technology, credit, training and other facilities available to male workers and farmers. Their role has been passive due to ignorance of modern inputs and methods of cultivation. Their regain energy is spent in procuring fuel, fodder, food and has little time to improve their skills. In the process they have lagged behind their male colleagues in using of improved crop production and processing tools and machinery. Besides hand tools and improved bullock drawn implements, more 240,000 tractors and 700,000 irrigation pumps are introduced every year for mechanization of Indian agriculture. But these improved implements are exclusively handled by male workers. The rural women are usually employed in most arduous field operations like sowing behind and plough, transplanting, weeding, intercultural, harvesting, threshing and agro-processing. It may be seen that women are largely employed in those operations most of which have not been mechanized.

In addition to crop production, women are also employed in other field operations in horticulture, agro-forestry, animal husbandry, dairying and fisheries. These sectors are least mechanized in India. Almost entire post harvest and agro-processing activities are performed by women. Which is socially accepted, irrespective of economic status of the women, fortunately mechanically powered simple equipment and gadgets are available in rural areas on custom for many of these operations and therefore women's drudgery has been reduced to a great extent. The custom services of rice milling, flour grinding and oil expelling are quite common in rural areas. This equipment reduce drudgery, facilitate utilization efficiency of inputs, ensure timeliness in field operations and reduce turnaround time for next crop, increase productivity of man-machine-power system, conserve energy, improve quality of work and also quality of produce.

To ensure that the women are equal beneficiaries of the agricultural mechanization it is necessary to develop women oriented training modules, machines, equipments, tools etc. But to

successfully implement a programme a researcher also needs to study the root cause of the problem. In the present context it is "lower level of mechanization among the farm women".

Hence, it was proposed to develop a checklist / scale which will ease the problem identification in the farm women of the specific location. Thus it will channel the efforts of the researcher in proper intervention.

In the first step a questionnaire was developed regarding the aspect of mechanization and probable issues. The developed questionnaire will be scrutinized and ranked by the experts. Latter a weighted scale will be prepared by selecting the highest ranked question.

B. CRITICAL REVIEW

Asefa (2005) posits that the "spatial dimension of crop production requires that the machines suitable for agricultural mechanization be mobile-they must move across or through materials that are immobile. The seasonal characteristic of agricultural production requires a series of specialized machines-for land preparation, planting, pest and pathogen control, and harvesting-designed for sequential operations", each of which is carried out for only a few days or "weeks in each season" thus in order or the farmer to improve and maintain competitiveness in the prevailing market environment by keeping consumer price as low as possible, the cost of production must be kept low as well. This can be achieved through agricultural mechanization which is labor-saving and capitalizing on economic opportunities, (Abdelali-Martini, 2011). The Food and Agriculture Organization (FAO) "estimates that equalizing access to productive resources for female and male farmers could increase agricultural output in developing countries by as much as 2.5 to 4 percent. Eliminating barriers preventing women from entering certain sectors or occupations would have similar positive effects, increasing output per worker by 13 to 25 percent." (The International Bank for Reconstruction and Development/The World Bank, 2011). Empowering women enables them to claim their rights to access land and fully utilize it and thus exploit available opportunities as well as make choices as to how to best use the land and therefore grow the economy, enhance food security and greatly improve the prospects for current and future generations. (Cullingford & Blewitt, 2013) It is more challenging for women who more often than not have a greater disadvantage because they not only contend with the limited access to the farm inputs but also structural differences that arise owing to cultural factors or legal rights to access capital or even land, let alone the technical knowledge to operate

the machines that are needed so as to get the desired yield. There is need for the governments in developing countries to focus on women by recognizing their input and efforts by empowering them so that they are able to contribute more in the agricultural sector as well as "strengthening their access to and control over productive resources/assets such as land, capital, knowledge, information and technologies, remain important factors of an enabling environment for women's empowerment". Women are the backbone of the rural economy significantly contributing to the economy especially in the developing countries of the world inasmuch as they do not own or receives as much land, financial access, farm inputs, agricultural training and other necessary information as compared to men. Given that "traditionally, women have been the repository of much knowledge concerning seeds and soils because of their roles in subsistence agriculture".

C. ISSUES

The improved technology package has been developed in the country for agriculture and agro-processing but these have selectively been adopted mainly by male farmers. The female farmers remained passive spectator and continued to adopt traditional practices. The reasons may vary from technological to marketing and social barriers. These issues may be grouped into:

1. Technological
2. Training and skill
3. Passive attitude towards modernization
4. Credit facilities
5. Marketing system
6. Social barrier

1. Technological barriers

The equipment for agriculture production processing and value addition are developed keeping ergonomic design factors of male operators. For women these are scaled down in size but their physiological responses under long duration of work are hardly investigated. Age, her physical strength, working posture and environment under which female workers are employed varies from region to region, which influences the adoption of technology.

2. Training and skill

The training facilities available for women, in selected trades, are largely located in cities and rural women can hardly avail these opportunities. Agriculture production related training facilities (agricultural machinery and equipment) are no where available to cater to the rural women needs. The programme confine mainly to demonstration of machinery and women hardly get chance to handle these machines. This does not improve the skill of women although, creates awareness and therefore, modern machinery does not generate interest among women worker.

3. Passive attitude towards modernization

In traditional agriculture women farmers were equally involved in decision making process. In the absence of knowledge of modern agriculture technology, men alone take the decision for modernization of agriculture and the female members are left behind as passive spectators. They give their share of labour through traditional tools and equipment. The attitude of women towards accepting modern machinery can be changed only through proper training and demonstration.

4. Credit facilities

The modern agriculture, including improved machinery, requires higher capital investment, which is not adequate from farmer's savings alone. The women farmers are not conversant with Banking system and procedure for availing loan and thus, are deprived of credit facilities for purchase of machinery and other agricultural inputs.

5. **Marketing system**

Purchase of improved machinery or sale of agro-produce requires knowledge of industries dealing in machinery and organized marketing network system for agro-produce. The women workers seldom handle such issues outside their village or local bazaars. Since marketing requires movement away from their villages, it will be appropriate to organize, group societies, to look after such issues. Network can be established like 'Contact farming', 'Franchise trading' supply to organized cooperatives for value added products for assured marketing.

Considering all the factors a questionnaire was developed. The questions were segregated in four categories i.e., existing level of mechanization, attitude, skill, and access & knowledge

Table 15. Questionnaires for review by experts

Existing level of mechanization of the farm women				
Sl. No.	**Questions**	**Highly recommended**	**Recommended**	**Not recommended**
1.	Do you know what is mechanization or any machines used in Agriculture?			
2.	Do you own a tractor?			
3.	Do you own self propelled machinery (power weeder rotary tiller etc?			
4.	Do you own animal operated implements?			
5.	Do you own a hand tools (sickle, weeder etc?			
6.	Do you hire tractor of machinery for agricultural operations?			
7.	If you hired any machines, are you getting the machine in time?			
8.	If you have own machine, are you giving for hire?			
9.	Do you have any animal power source?			
10.	Do you have hired labour in the farm?			
11.	Do you work on your own field?			
Attitude of farm women towards mechanization				
Sl. No.	**Questionnaires**	**Highly recommended**	**Recommended**	**Not recommended**

12.	Do you think due to machines, cultivation time decreased?			
13.	Do you think due to machines, yield increases?			
14.	Do you think the machines are affordable?			
15.	Do you think machines are safe to use?			
16.	Do you think machines are easy to operate?			
17.	Do you think machines are easy to maintain?			
18.	Do you think available machines are perfect to your body size?			
Skill level of farm women				
Sl. No.	**Questionnaires**	**Highly recommended**	**Recommended**	**Not recommended**
19.	Have you undergone any training programme on farm mechanization?			
20.	Are you interested to attend any training programme on farm mechanization?			
21.	Do you operate machine or tools?			
22.	Are you interested to operate machine or tools?			
23.	Do you have concerns regarding using of machines?			
24.	Do you do basic maintenance of machines or tools?			
25.	Do you require a trained mechanic for maintenance to machines and tools?			

26.	Do you think the machines are available in market need some modification for better performances?			
Access and knowledge of farmwomen				
Sl. No.	**Questionnaires**	**Highly recommended**	**Recommended**	**Not recommended**
27.	Do you have any awareness about any government schemes for mechanization?			
28.	Have you availed any subsidy for purchasing tools?			
29.	Is the process of availing subsidy easy?			
30.	Do you have any custom hiring centers in your locality?			
31.	Are spare parts of machine easily available in your locality?			
32.	Are machines are available in market as per your requirement?			
33.	Are you getting proper knowledge regarding machines from any government/ private/ company?			

Section - III

OTHER INFORMATION

1. Annual Review Meeting

The annual review meeting and future road mapping of the work was done for AICRP on ESA at ICAR-CIWA on 3 July, 2018 under the chairmanship of Dr. S. K Srivastava, Director, ICAR-CIWA. Dr. K. N Agarwal, (PC, AICRP on ESA), Prof. S K Mohanty, Professor & PI, AICRP on ESA OUAT attended the meeting. At the outset the PI , Er. Chaitrali S. Mhatre presented the work done on AICRP on ESA at ICAR-CIWA. Dr. K N Agarwal scrutinized the projects and offered valuable suggestions for further enhancement of the project work and outcomes. He suggested to focus the work of the centre on need based product development as well as development of proper training module for farm women. He visited the women friendly tools repository, Ergonomics lab and training cum manufacturing unit of ICAR-CIWA. He appreciated the efforts taken to establish the facilities. Prof. S K Mohanty, extended his guidance and valuable input regarding the projects.

Glimpses of the meet

Visit to Manufacturing and training unit

Visit to Women friendly tools repository lab

2. Technologies Transferred:

During FLDs training was exclusively given to farm women with regards to machinery assembly, disassembly, and repair & maintenance and field operation. The FLDS were done in different districts of Odisha like Lamptaput block of Koraput district , Jashipur block of Mayurbhanj district, Keonjhar, Nabarangpur etc. Information regarding tools and equipments such as weeders, seed treatment drum, threshers winnowers, hand ridger ground nut decorticator, maize deshusker cum cheller etc where transferred to the farmers. Glimpses of the FLD programs is as below:

a. FLD in Lamptaput block of Koraput

Interaction with farm women

Anthropometric data

Training regarding, assemble, disassembly, repair and maintenance of farm tools

Heart rate reading


On field training of farm women for operation and adjustment of tools

b. FLD in Jashipur block of Mayurbhanj



Anthropometric data Interaction with farm women and training regarding , assemble, disassembly, repair and maintenance of farm tools



On field training of farm women for Assembly, adjustment of tools, Operation and Safety

c. FLD in Mayurbhanj

Practical demonstration of twin wheel hoe in Chilli plant

Training on safe opertion of sprayer

Demonstration of seed treatment unit

d. FLD in Nabarangpur

Demonstration of assembly and disassembly of tools for women beneficiaries

Training on proper operation of twin wheel hoe

e. Tools and implements explained to <u>Keonjhar</u> district farmers visiting the women friendly tools repository of ICAR-CIWA centre

Explanation of proper handling of improved sickle to farmers

Explanation of drum seeder

Explanation of care to be taken while operating cono weeder

Explanation of benefits of use of CIAE improved cook stove and other women friendly tools

f. Demonstration of women friendly tools and implements to the farmeers visiting from mayurbhanj district

Demonstration of twin wheel hoe to farmers

Farmers operating twin wheel hoe

Answering the queris of women farmers regarding tools

Women farmers operating the tools