

Research Paper :

Agricultural engineering interventions to increase the efficiency of women in agriculture: some studies from India

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ABSTRACT

The woman is the backbone of the agricultural workforce, but worldwide her hard work has mostly been unpaid. She does the most tedious and back-breaking tasks in agriculture, animal husbandry and homes. The research efforts at the ICAR institutes have been tried to relieve her of the drudgery by providing time and labour saving tools such as improved weeders, winnowers, threshers, paddy transplanters. The interventions were also provided in the areas of nutritional security, dryland and irrigated agricultural technology etc. Vocational trainings are also being conducted to impart skills to undertake different vocations. In extension activities the women is now centre point and activities are being planned keeping her in view. Her enlightenment will change the face of the rural India. Women are involved in various activities related to agricultural and allied enterprises and some of these activities have found to have profound health risks on women. In such situation introduction of agricultural implements has been proved effective in relieving drudgery. Present paper is such an effort to analyse studies conducted by various ICAR institutes in improving efficiency and boosting agricultural production through agricultural engineering interventions. These studies were conducted at various ICAR institutes such as National Research Centre for Women in Agriculture(NRCWA), Bhuvaneshwar, Orissa, Bhopal sub center of NRCWA, Central Institute of Agricultural Engineering (CIAE), Bhopal, Central Research Institute for Dryland Agriculture (CRIDA),Hyderabad, Central Rice Research Institute (CRRI), Orissa, Krishi Vigyan Kendras sponsored by Indian Council of Agricultural Research, New Delhi, and through the networking of these institutes with various states.

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The general trend existing in rural India is limited resources available to women because of low socio-economic status in the society and within that limited access to resources, there exists a strong disparity that, most of the women's earnings goes towards nutritional security of the households. However, in the recent past there is a trend, *i.e.*, agricultural engineering with women's perspective is gaining importance. The effective application of agricultural technologies in production has strategic gender implication. The productivity of the labour will be altered, depending on the accessibility for average small and marginal landholders. Most women cannot invest in the technology. Introduction to new technologies in agricultural operation adopted by farm women leading to the mechanisation will reduce the drudgery and improve the efficiency. It is found that, participation of women in farm operations is as high as 95 per cent in Andhra Pradesh to as low as 1.5 per cent in Haryana. About 78 per cent of economically active women are engaged in agriculture compared to 63 per cent of men almost 50 per cent of rural women are classified as agricultural

labourers and 37 per cent as cultivators. In such conditions where participation of women in agriculture is as high as 95 per cent the women need to have the précised agricultural tools and implements. Because women workers when engaged in agriculture and allied activities, timeliness and precision play an important role in improving the input use efficiency and to harvest the benefits of limited soil moisture. Timeliness is a function of optimum number of days available for farm operations and number of days required for completion of operation. Precision is influenced by abilities of implements used to meet the soil/crop requirements.

Men and women need to work together in harmony. They are interdependent on each other. In addition to performing household chores women are required to participate fully in crop production. Men have generally done better in the use of agricultural engineering technologies, while women are left behind. It is also felt that, the available agricultural technologies are not women friendly as they are not designed taking into consideration the women's ergonomic measurements. Because, there

exists a communication gap between design engineers and farm planners and also the lack of women's access to articulate their felt needs. With this backdrop, Govt. of India has encouraged the scientists to work for women in agriculture by establishing national Research centres for women, and promoting pro-women programmes in different facets of agriculture and allied enterprises. These centres work towards identifying the gender issues and test appropriateness of available farm-technologies / programmes/policies with women's perspective, for promoting gender mainstreaming in research and extension for empowerment of farm women and capacity building of scientists and policy makers to respond to the needs of farm women. There are some studies carried out in different research centre to reduce the drudgery of farm women and to overcome the labour deficits during peak season. This paper throws light on analysing these studies with the following objectives, to review and analyse various research studies on agricultural engineering interventions to increase the productivity of women in agriculture, to assess the level of impact of agricultural engineering interventions, to identify the needs of farm women in adopting technologies and to assess the impact of these interventions on socio-economic status of the farm families.

METHODOLOGY

Though there is long list of agricultural activities in

which women are involved, the present paper is limited to analyse the studies related to nutritional security of the family, access to water, sowing/transplanting operations, weeding and interculture, harvesting and threshing, Entrepreneurship development activities, dryland agriculture technologies and training needs of farm women. These studies were conducted at various ICAR institutes NRCWA, Bhuvaneshwar, Orissa, Bhopal subcenter of NRCWA, CIAE, Bhopal, CRIDA, Hyderabad, CRRI, Orissa, KVKs sponsored by ICAR, New Delhi, and through the networking of these institutes with various states.

RESULTS AND DISCUSSION

The findings obtained from the present study have been discussed in the following sub heads :

Nutritional security of the farm families:

The studies conducted on increasing food security through aquaculture are presented in Table 1.

Under the project on Standardisation of weaning mix using different proportion of sweet potato, standardisation of a low cost weaning mix by utilizing locally available food materials was carried out. Dehydrated materials from sweet potato, green leaves and potato were prepared and kept in air tight containers and polythene bags for evaluating its shelf life. The base containing roasted flake powder, roasted wheat powder, pulses (0.50 green gram

Table 1 : Nutrition security of families through aquaculture

Sr. No.	Title of the project	Sample	Area	Activities under taken	Economic analysis	Intangible gain
1.	Ornamental and integrated fish farming	194 families involving 240 women	8 ponds covering 0.22 ha	Fish-cum-duck Fish-cum-poultry Fish-cum-horticulture	Income of Rs. 200-500/month Income of Rs.6.5 lakhs/year Fish yield increased from 0.125 to 2.88 tonnes/ha	Availability of healthy and desired species of fishes. Economic security to the families.
2.	Ornamental fish production-a new avenue for supplementing farm income	12 SHGs having 10-12 earthen tanks	Slight modification of earthen tanks of 50-60 lit capacity	Guppy and Mollys <i>sp.</i>	Rs. 560 average/month income on investine Rs 2000 Rs 1400 average/month income on investing Rs. 5000.	Enabled rural youth earn a monthly income of Rs. 3000.
3.	Involving rural women in aquaculture- a step towards enabling economic and nutritional security	56 backyard ponds	-	Fish culture and nursery rearing of rohu and catla <i>sp.</i>	Daily income for sustaining their lives	Water analysis, pond preparation, cleaning of weeds, removal of weed fishes, manuring and lime application to ponds

(DARE/ICAR, 2007 and 2008).

dal+0.50 bengal gram dal) and sesame seeds powder in the ratio of 2:1;1:0.25 was preferred as weaning mix. Table 2 represents nutritional composition of weaning mix. The base and the dehydrated sweet potato powder in the proportion of 75:25 were ranked first. Weaning mixes, which were rich in protein, energy and beta carotene required for growth and development of the children were most preferred. The unit cost of such weaning mix was very low (Rs. 23.90/kg). The intervention empowered farm women in utilizing locally available foods and enhancing the nutritional security.

Table 2 : Nutrient composition of weaning mix

Nutrients	Level
Moisture (%)	5.81
Crude Protein (%)	10.86
Crude fat(%)	5.89
Total ash(%)	1.95
Crude fibre	2.78
Energy value(K/cal/100g)	456.00
Beta carotene	84.54
Dry matter (%)	94.14

(DARE/ICAR, 2007)

A low cost storage structure-zero energy cool chamber (ZECC) suitable for farm families was constructed and storage studies of fruits/vegetables like tomato, French bean, carrot, orange and mango were carried out at ambient temperature, low temperature and in the ZECC. The shelf life and quality of perishables (fruits and vegetables) in ZECC was at par with the quality at low temperature (refrigerator). The ZECC was very useful for small farmers during summer as it maintained at a temperature of 25-28^o C with a relative humidity of 85-90%. A structure of 170 x115x70 cm costing approximately Rs. 3500 could store 100 kg of vegetables.

Sowing/transplanting operations by women:

Transplanting operation is a tedious operation which is normally performed by women power in upright bending posture. A women has to dip her hand 6000-7000 times for transplanting of paddy seedlings in standing water. This posture when continued for years together results in low back pain (LBP) and spinal disorders. This arduous operation can be made more comfortable by the use of direct paddy seeders. The development and evaluation of direct paddy seeder for assessing the suitability to rural women was carried out at research farm, Tamilnadu Agricultural University, Coimbatore (Sirisha *et al.*, 2008). Three types of paddy seeders namely two row, three row

and four row paddy seeder were fabricated using three types of material namely plastic, galvanised iron (GI) and fibre reinforced plastic (FRP) for reducing the weight of the unit. Ten female subjects were selected for the investigation based on the age. The parameters used for the ergonomical evaluation include heart rate, oxygen consumption rate, energy cost of operation, acceptable work load, work pulse, overall discomfort rating, body part discomfort score and force required to pull the paddy seeder. Based on the data analysis, the suitable types of direct paddy seeder was recommended.

Performance of three types of direct paddy seeders were carried out in the puddle soil using 10 female subjects. The ergonomical parameters pertaining to women and machine parameters were noted and are presented in the Table 3.

Table 3 : Performance evaluation of the dire paddy seeders operated by women

Sr. No.	Parameters	Two row paddy seeders	Three row paddy seeders	Four row paddy seeders
1.	Type of material	Plastic	GI	FRP
2.	Heart rate, beats/min	124.43	126.53	152.50
3.	Oxygen consumption rate m ³ /min	0.535	0.635	0.6981
4.	Field capacity, ha/hr	0.025	0.032	0.0625

Based on the ergonomical evaluation and machine parameters, the results revealed that four row paddy seeder with FRP performed better for transplanting work operated by women (Sirisha *et al.*, 2008).

The ergonomical evaluation of manually operated two row drum seeder, TNAU four row drum seeder and CRRI four row rice transplanter was carried out with women workers (DARE, 2006) The ergonomical parameters for women workers such as heart rate, pulse rate were measured and noted.

The test results of ergonomical parameters such as heart rate and pulse rate for two row drum seeder, TNAU four row drum seeder, and CRRI four row rice transplanter were 110 beats/min 40 beats/min, respectively. A manually operated seed drill weighing about 13.80 kg was developed at NEH, Barapani centre of AICRP on FIM. The overall dimensions of seed drill were 870x440x110mm. The drive ratio from ground wheel (diameter 400 mm) to metering shaft was 1:1. The seed drill consisted of v-shaped furrow openers, seed hopper

(capacity 2 kg) and cup feed type seed metering unit (DARE, 2006). The manually operated seed drill was operated by two women workers for sowing maize and pigeonpea. The seed drill worked satisfactorily (DARE, 2006).

An ultra light hand operated rice transplanter for transplanting of paddy seedlings operated by women power was developed and evaluated (Quick, 1991). The paddy transplanter was made of steel, aluminium and wood which weighed about 13 kg. A detachable bicycle wheel at the front and lockup handle allowed the women farmers to push it like a wheel barrow along narrow field bunds. The Wheel can be removed quickly.

A hand operated rice transplanter operated by women workers for transplanting work was evaluated in the puddle field. The paddy transplanter worked satisfactorily as the wooden skid kept the transplanter from sinking in the puddle soil. The field capacity of the transplanter was 0.2 ha/day (Quick, 1991). Animal drawn CIAE planter for planting of groundnut, maize, pigeonpea sorghum and other oil seed crops was tested for its performance (Sarma, 2004). The implement was designed and developed CIAE, Bhopal. The CIAE, Bhopal and the results revealed that, the cost of the unit was Rs. 5000/- and cost of operation was Rs. 90/ha. The field capacity of the unit varying 0.12-0.15 ha/hr with field efficiency of 60-65 % (Sarma, 2004).

Weeding and intercultural operations by women power:

Ergonomic evaluation of push pull type weeder with women operators was carried out in Bhubaneswar for weeding operation (Behera *et al.*, 2007). Three types of weeders namely Rotary Peg Weeder (RPW), Wheel Hoe (WH) and Wheel Finger Weeder (WFW) were evaluated including machine parameters and ergonomic parameters. The machine parameters such as field capacity, weeding index, pushing force and ergonomic parameters such as heart rate, oxygen consumption rate, acceptable work

load, energy expenditure rate were measured for different women workers and analysed. The results are presented in Table 4.

The body parts discomfort score revealed that, wheel Finger Weeder performed better followed by RPW and WH. The grading of work showed that, weeding with WH was heavy followed by RPW and WFW for women operators (Behera *et al.*, 2007).

The weeding operation by using long handled weeder was compared with traditional weeding tool operated by women to assess the ergonomic parameters to promote health, efficiency and quality of work. The weeding operation was carried out in vegetable fields on 30 women workers in the age group of 25-40 years. The ergonomic cost of weeding activity was calculated in terms of heart rate and energy expenditure (Singh *et al.*, 2007). The rest results showed that, the long handled weeder was more efficient, reduced average working heart rate, energy expenditure. The weeding operation by long handled weeder reduced the bending and squatting posture (Singh *et al.*, 2007).

Harvesting, threshing and winnowing operations by women workers:

The study on drudgery reducing farm implements operated by women such as improved sickle and tubular maize cob sheller were carried out in mundla village of Kangra district of Himachal Pradesh, India (Sharma, 2002). Perceived feasibility has been operationalised by women as profitable, compatibility, simplicity-complexibility, triability and observability. The parameters were measured and analysed. The results on improved sickle revealed that, 75% perceived the sickle as profitable (78.33%), compatible (76.77%), triable (75%) and observable (73.33%). Regarding the use of tubular maize cob sheller, 61.67% perceived the unit as profitable, compatible (73.33%), neither simple nor complex (58.33%), triable (66.67 %) and observable (58.33%). Both sickle and tubular maize cob sheller were most

Table 4 : Test results of push-pull weeders for women

Sr. No.	Parameters	Rotary peg weeder (RPW)	Wheel hoe (WH)	Wheel finger weeder (WFW)
Machine parameters				
1.	Field capacity, Ha/hr	0.0315	0.0295	0.0195
2.	Weeding % index	77.20	71.00	70.80
3.	Pushing force, N	142±3.09	164±4.22	126±2.37
Ergonomic parameters				
1.	Heart rate, Beats/min	115.80±1.47	128.7±1.67	116.30±1.35
2.	Oxygen Consumption rate, %	34±3.2	52±2.3	37±1.74
3.	Energy expenditure rate, KJ/min	12.80	19.53	13.67

feasible by majority of the farm women (Sharma, 2002).

Self-Propelled vertical conveyer reaper developed by NEH, Barapani centre of AICRP on FIM was evaluated for harvesting of paddy crop (DARE, 2006). The area covered and field capacity were measured and analysed. The performance of self propelled vertical conveyer reaper for harvesting of paddy crop was demonstrated in valley land of the region. The demonstration plots covered an area of 5.0 ha and 6.0 ha in different locations. The average field capacity of the machine was found to be 0.05 ha/hr. and worked satisfactorily (DARE, 2006).

Ergonomical evaluation of manually operated OUAT ESA pedal operated paddy thresher was carried out in Bhubaneswar, India, (DARE, 2007). The different machine parameters such as grain output capacity, throw out capacity speed of operation, force for pedal operation and ergonomical parameters such as heart rate of women, pulse rate were measured and analysed. The performance results of manually operated paddy thresher are present in Table 5.

Table 5 : Performance results of manually operated paddy thresher by women workers

Sr. No.	Parameters	Value
Machine parameters		
1.	Throw out capacity, kg/hr	79
2.	Grain output, kg/hr	24
3.	Speed, strokes/min	77
4.	Force of pedal operation, N	162
5.	No. of operators	02
Ergonomical parameters		
1.	Heart rate, beats/min	136
2.	Pulse rate, beats/min	53

The paddy thresher operated by women workers worked satisfactorily.

A motorized paddy thresher was developed at NEH, Barapani, India and promoted in that region (DARE, 2006). The threshing capacity of paddy crop can be carried out by holding paddy bundles against moving cylinder and blower helps to throw the broken chaff at some distance away from machine. The overall dimensions of thresher was 8500x7500x7500 mm and total weight excluding motor was 50 kg. Two persons were necessary for carrying out threshing operation. The test results of motorized paddy thresher revealed the grain output was 4-5 times more than pedal operated paddy thresher. The labour requirement in power thresher was

one man-hour and 5 man-hour for pedal thresher. The save in labour requirement was 80% and saving of cost of threshing was 74% when compared to pedal thresher (DARE, 2006). A hand operated paddy winnower developed by CRRI, India was evaluated for winnowing of paddy crop using 12 women subjects. Two women workers were required for operation of winnower, once for cranking the blower and other for feeding the threshed material and collection of grain. The ergonomical parameters such as heart rate, energy expenditure rate and machine parameters such as output, winnowing efficiency were measured and analysed (Singh and Gite, 2007). The test results of hand operated paddy winnower by women workers are presented in Table 6.

Table 6 : Tests results of hand operated paddy winnower by women

Sr. No.	Parameters	Value
Machine parameters		
1.	Grain output, kg/hr	242
2.	Winnowing efficiency, %	88.36
3.	Subjects	12 women
Ergonomical parameters		
4.	Heart rate, beats/min	112
5.	Energy expenditure, KJ/Min	10.70

The paddy winnower worked satisfactorily for women workers as the heart rate, work pulse rate and energy expenditure rate were within the acceptable limits (Singh and Gite, 2007). Ergonomical evaluation of manually operated CRRI rice winnower was carried out for paddy crop (DARE, 2007) The machine parameters such as grain out put, speed of operation, torque; the ergonomical parameters such as heart rate, pulse rate were measured and analysed. The performance results of CRRI rice winnower are presented in Table 7.

Table 7 : Performance results of CRRI rice winnower by women

Sr. No.	Parameters	Value
Machine parameters		
1.	Grain output, kg/hr	242
2.	Speed of operation, rpm	65
3.	Torque, N-m	5.30
4.	No. of women workers	2
Ergonomical parameters		
1.	Heart rate, beats/min	112
2.	Pulse rate, beats/min	31

The results revealed that, the ergonomical parameters were within acceptable limits (DARE, 2007).

The paddy winnower was demonstrated in North Eastern region as the farmers were mainly dependent on natural wind (DARE, 2006). The purpose of winnower was to clean the grain by blowing artificial air. The women workers were employed for operation of winnower.

The test results on paddy winnower demonstrated on North Eastern region revealed that, the output of winnower was 2.5-3.5 q/hr for paddy crop (DARE, 2006). The paddy winnower was gaining popularity among the farmers in this region. The winnower was demonstrated for 200 hours at different locations.

Use of women power in dryland Technology:

In rainfed agriculture, timeliness and precision play an important role in improving the input use efficiency and harvested benefits of limited soil moisture. In rainfed agriculture, women are engaged in various agricultural operations such as sowing crops behind the country plough, weeding operations, harvesting of crops, plucking of fruits and vegetables, threshing and harvesting of field crops, transporting and feed straw, chopping of fodder etc. These operations involve drudgery (Subba Reddy, 2004).

The woman power engaged in various farm operations for crop production is presented in Table 8.

Entrepreneurship Development through SHGs:

Under Mission Mode NATP Empowerment of women in agriculture, 540 farm women were grouped into 36 SHGs for starting different enterprises based on the needs and preference of farm women, resources available and marketing potentiality in the area. Trainings were organised for capacity building of farm women of the SHGs in the enterprises. The members of SHGs were also trained to handle different equipments. Empowerment of women SHGs have been made by skill training and orientation to project management aspects. All the members of SHGs started enterprises as per their interest. The women have started generating income from enterprises. The income generating activities taken up by the SHGs included home made products, bakery products, small business, tailoring/embroidery, goat/buffalo rearing and vermin composting. As an innovative approach, marketing outlet for SHGs (Saturday and Sunday Bazaars) were initiated to encourage SHGs in Karnataka. The SHGs were allowed to sell the goods in these bazaars after the necessary skill training at KVKs.

Table 8 : Appropriate technologies of crop production for reducing drudgery of farm women in dryland technology

Sr. No.	Farm operation	Low cost simple farm implement/tool	Type of drudgery removed
1.	Tillage	Improved animal drawn plough Three type cultivator Blade harrow Multipurpose tool frame	Walking upto 20-25 km/day while operating country plough is reduced
2.	Sowing	Manually oerated seed drill Plough planter Animal drawn seed cum fertilizer drill	Removes drudgery of walking in bending posture, saves time and lesser cost.
3.	Weeding	Wheel hoe Peg type weeder Cono weeder	Avoid drudgery of working in squatting posture.
4.	Harvesting	Improved sickle with seerated edge blade Self propelled reaper of 1.0 m size Animal drawn groundnut digger	Reduced harvesting time by 40% more efficient and long life
5.	Threshing	Tubular maize sheller Hand operated maize sheller Paddy threshing bench Paddy thresher Groundnut pod stripper Groundnut decorticator	Work output is high and operational time is reduced by half in case of manually operated machines
6.	Transport	Improved bullock cart Handy trolley Bicycle	Avoid carrying loads on head or back. Agriculture produce can be easily transported.

The appropriate low cost technologies for farm women benefit the farming community (Subba Reddy, 2004).

The products in the market included fresh fruits, vegetables, pickles, crisp rotis of jowar and bajra. On an average 50 SHG members participated in the bazaar and weekly transaction varied from 15,000 to 20,000. This was a model and was being experimented at other places and found successful.

Mango nursery as an alternative for income generation for women was started in five talukas of Mahaboobnagar district of Andhra Pradesh prior to this activity, necessary skills were provided through the trainings. The proper marketing of the mangoes in the intra village selling and other markets have given them profit on their investments. Table 9 gives the overall picture of the income gained by the farm women through mango nursery.

The data on Entrepreneurial status of SHGs revealed that, majority of group members belonged to the agricultural families with marginal land holdings. Most of the SHGs, however, existed for a long time without involvement in any enterprise their interest and preference in skill training were assessed and skill development

Table 9 : Income generation of farm women through mango nursery

Particulars	Kistagiri	Villages Rajapeta	Kamblapur
No. of Women	40	55	45
Year of training	1995-96	1995-96	1996-97
Year initiated	1995	1995	1996
Seedlings bagged (no)	5,000	7500	10000
Successful seedlings (no)	4500	5500	7000
Expenditure(Rs)	20000	26000	32000
Successful grafts made (no)	3000	3500	5000
Sales (Rs)	45000	52500	75000
Net income (Rs)	25000	36500	48000

training programmes were organised on vermicomposting and bee keeping (DARE/ICAR, 2007).

Table 10 : Perceived training needs of farm women

Area of training	Perceived training needs of farm women
Efficient resource management of women Agricultural labourers for sample of 200 women. (DARE/ICAR, 2006-07)	Under this project 42% women agricultural labourers wanted training in livestock management, vegetable production, backyard poultry farming and tailoring and stitching. And another 44% perceived need for training on vegetable production, improved agricultural practices, livestock management and vocational training for self employment.
Trainings and exposure visits were conducted on use of improved agricultural implements and tools, production techniques including insect pest management of vegetable nursery and production of vermicompost. (DARE/ICAR, 2006-07)	Trainings and exposure visits were conducted on use of improved agricultural implements and tools, production techniques including insect pest management of vegetable nursery and production of vermicompost.
Training imparted to farm women in different aspects of agriculture and allied enterprises Insect pest management of vegetables nursery (286) vermicomposting (286) value addition of lime and ginger into squash, blended squash and pickle(286) Preparation of <i>sagu papad</i> and <i>suji papad</i> Oyster mushroom production and bee keeping. (286)	
Improved tools and equipments (hand ridger, seed treatment drum, fertilizer broadcaster, seed drill, CIAE wheel hoe, PAU wheel hoe, grubber weeder, handing type cleaner and sitting type decorticator) (200)	
Training on repair and maintenance of these equipments(14)	
Improved tools and equipments (Fertilizer broadcaster, 2-wheel seed drill, one-wheel seed drill, twin-wheel weeder, groundnut decorticator, hanging type grain cleaner, naveen dibbler, seed treating drum and furrow and bund maker) for a sample of 155 farm women (DARE, 2006)	
Soybean processing and production of soymilk, soy paneer, bakery items and soy snacks and health benefits (2005-06, CIAE, Bhopal)	
Trainings and exposure visits were conducted on use of improved agricultural implements and tools, production techniques including insect pest management of vegetable nursery and production of vermicompost.(DARE, 2006)	
Trainings and exposure visits were conducted on use of improved agricultural implements and tools, production techniques including insect pest management of vegetable nursery and production of vermicompost.	

Training needs of women:

The following table gives the details on perceived training needs of farm women and the trainings provided. These trainings were provided at CIAE Bhopal.

Conclusion:

Agricultural interventions should be directed to individual small holders, SHGs and adapted to women's roles as farmers and resource managers, ensuring better nutritional status of the family and involve them in developing and providing agricultural technologies, micro-credit and extension and land redistribution in order to increase the demand for women's paid labour in rural areas. There is a need to examine the gender specific effects that integrate intra-household dynamics and social stratification into models to test the socio-economic impacts of technological change.

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REFERENCES

Behera, B.K., Swain, S. and Mohanty, S.K. (2007). Ergonomic evaluation of push-pull type weeders with women operators. *J. agric. Engg.*, **44**(3) : 39-43

DARE (2006). Gender issues for technological empowerment of women in agriculture, ICAR, Annual report 2006-07, pp ; 184-189.

DARE (2007). Gender issues for technological empowerment of women in agriculture. ICAR, Annual report 2007-2008. Pp.116-118

Quick, G. (1991). Ultra-light rice transplanters can make life easier for women. *Indian Fmg.*, **41**(2) : 29.

Sarma, Aum (2004). Mechanisation for major oil seeds and cereals in dry lands, winter school on mechanisation of dryland agriculture, CRIDA, Hyderabad. pp. 363-371.

Sharma, Neetu (2002). Perception of farm women about feasibility of drudgery reducing farm implements. *Ann. Biol.* **18** (2) : 209-210.

Singh, S.P. and Gite, L.P. (2007). Ergonomical evaluation of a hand operated paddy winnower by women workers. *J. agric. Engg.*, **44**(4) : 67-71.

Singh, Suman, Mathur, Puja and Rathore, Madhu (2007). Weeders for drudgery reduction of women farm workers in India. *J. agric. Engg.*, **44**(3) : 33-38.

Sirisha, D., Manian, R. and Kathirvel, K. (2008). Development and evaluation of direct paddy seeder for assessing the suitability to rural women. *AMA, Agricultural Mechanisation in Asia, Africa & Latin America*, **39**(4) : 41-45.

Subba Reddy, G. (2004). Small farm mechanization to reduce drudgery of farm women in rainfed agriculture, Winter school on Mechanization of dryland agriculture. Central Research Institute for Dryland Agriculture. pp. 305-312.

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