

Agricultural Engineering Interventions to Increase the Productivity of Women in Agriculture: Some Studies from India

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Abstract

The woman does the most tedious and back-breaking tasks in agriculture, animal husbandry and homes. The research efforts at the Indian Council of Agricultural Research (ICAR) institutes have 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 woman is now the centre point and activities are being planned keeping her in view. Women are involved in various activities related to agricultural and allied enterprises and some of these activities are 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.

Introduction

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. Most women can not 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. About 78 per cent of economically active women are engaged in agriculture compared to 63 percent of men. Almost 50 per cent of rural women are classified as agricultural labourers and 37 percent 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.

In addition to performing household chores, the women are required to participate fully in crop production. It is generally felt that, the available agricultural technologies are not women friendly as they are not designed taking into consideration the women's ergonomic measurements. 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 centres 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 a 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 and training needs of farm women. These studies were conducted at various ICAR institutes NRCWA, Bhubaneswar, 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 discussions

Nutritional security of the farm families

Aquaculture is one of the prominent generating and family sustaining activity in many parts of the country. The studies conducted on increasing food security through aquaculture are presented in table 1.

Table 1. Nutrition security of families through aquaculture

Sl. 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	<ul style="list-style-type: none"> • Income of Rs. 200-500*/month • Income of Rs.6.5 lakhs/year • Fish yield increased from 0.125 to 2.88 tonnes/ha 	<ul style="list-style-type: none"> • 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 investing 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

(1 USD= Rs.50)

(DARE, 2007 and 2008).

Under the project on standardisation of weaning mix using different proportions 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 dal+0.50 bengal gram dal) and sesame seeds powder 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(Kcal/100g)	456.00
Beta carotene	84.54
Dry matter (%)	94.14

(DARE, 2007).

A low cost storage structure-Zero Energy Cool Chamber (ZECC) suitable for farm families was constructed and the 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° C with a relative humidity of 85-90%. A structure of 170 x115x70 cm costing approximately Rs. 3500 could store 100 kg of vegetables.

Community –Based Water Harvesting Systems and Gender Equity

A woman may have to get 20 litres a day of drinking water, 160 litres for other uses for her family, and another 200 litres for cattle. NGOs have successfully trained women to design, execute and manage water resources projects; they have brought in more than an element of equity in women's lives. Cost sharing is another aspect of equity. Women acquire symbolic capital through sharing costs of building and maintaining water management structures. Research Conducted at various places in India like Rajasthan and Orissa shows that women support equal distribution of costs as this helps them gain in intangible benefits. Oxfam project provided women provided resources to construct water tanks and given them entitlement to the adjacent land and women developed horticulture patches. In 1986, the Gujarat Water Supply and Sanitation Board (GWSSB) requested SEWA members to strengthen village water committees (*pani samitis*) and take over failing water supply systems. SEWA's members identified the need to find non-water based economic work, conserve water, revive traditional sources like surface

wells and ponds, and create alternative water sources through rainwater harvesting after undergoing necessary skill training.

In Pune, Maharashtra, the Society for Promoting Participatory Eco-System Management (SOPPECOM) negotiated water rights for a group of landless women. In Pali and Bharathpur women learnt how to assert themselves in governance and raise their priorities in the development of the village and women played a lead role from planning, through construction of structures and maintenance. In this drought prone district the tribal women redesigned the drought mitigation plan to deal with water stress. They conducted participatory planning, estimated mechanisms for catchment management, introduced a series of gully control methods and revived rainwater harvesting structures (RWS). Their active involvement gave them a say in the water management of the area and ensured water security. The women now use the RWS for pisciculture also. In order to deal with water shortages, Oxfam provided women with resources to construct water tanks, on the condition that they would be entitled to the land around it. As a result, the women developed the land into horticulture patches. A group of women in Pali constructed watershed development structures and they were also able to negotiate the interests of vulnerable castes on to access to the water. Shirahatti et al (2007) developed a capacity building model for rural women for irrigation water allocation to water users' associations. This pioneering work attracted the attention of INPIM and other institutions.

UNICEF training women as skilled masons, who were so committed in putting their skills to practice that they succeeded in bidding for the construction of a public building. The skills acquired helped them in doubling their income, enhanced their prestige and position in the families by making them equal contributors. In the Betalghat region Dalit women were struggling with managing forest nurseries and community forest management in the wake of severe water shortages. To deal with the water shortage, they constructed water buggies for water supply. This enabled them to address their immediate water needs and established their right to participate in the decision-making processes over water resources and community forests.

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 presented in table 3.

Table 3. Performance evaluation of the direct paddy seeders operated by women

Sl. 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 performed better for transplanting work operated by women (Sirisha *et al.* 2008).

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.

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. 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 results are presented in table 4.

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

Sl. No.	Parameters	Rotary Peg Weeder (RPW)	Wheel Hoe (WH)	Wheel Finger Weeder (WFW)
I.	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
II.	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

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).

Studies conducted on the weeding operation used two types of weeders namely, improved version and light weight version wheel hoe. The field trials involved 40 women in 4 villages and compared with local hoe. The performance results revealed that, the light weight hoe judged as best by the women for improving the quality of weeding. The cost of light weight wheel hoe and drudgery also reduced (Rana *et al.* 1994).

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

Ergonomical evaluation of manually operated OUAT ESA pedal operated paddy thresher was carried out in Bhubaneswar, India, (DARE, 2007). The performance results of manually operated paddy thresher was presented in table 5. The OUAT ESA pedal operated paddy thresher used by women workers worked satisfactorily.

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

Sl. No.	Parameters	Value
I	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
II	Ergonomical Parameters	
1	Heart rate, beats/min	136
2	Pulse rate, beats/min	53

A hand operated paddy winnower developed by CRRI, Orissa 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 test results of hand operated paddy winnower by women workers is presented in table 6.

Table 6. Performance of hand operated paddy winnower by women

Sl.	Parameters	Value
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No.		
I	Machine Parameters	
1.	Grain output, kg/hr	242
2	Winnowing efficiency,%	88.36
3	Subjects	12 women
II	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).

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 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 vermi composting. *As an innovative approach, marketing outlet for SHGs (Saturday and Sunday Bazars)* 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. 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 Rs.15,000 to 20,000. This was a model and was experimented at other places and found successful. (DARE/ICAR, 2003-04)

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 gave them profit on their investments. (DARE/ICAR, 2003-04). Table 7 gives the overall picture of the income gained by the farm women through mango nursery.

Table 7. 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

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 training programmes were organised on vermicomposting and bee keeping (DARE/ICAR, 2007-08).

Training Needs of Women

The table 8 gives the details on perceived training needs of farm women and the trainings provided. These trainings were provided at CIAE Bhopal.

Table 8. Perceived Training needs for empowerment of farm women

Area of training	Perceived training needs of farm women
<i>Efficient resource management of women Agricultural labourers</i>	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, improved agricultural practices, vocational training for self employment.
Trainings and exposure visits	Use of improved agricultural implements and tools, production techniques including insect pest management of vegetable nursery and production of vermicompost, soybean processing, mushroom production, bee-keeping and value addition to lime and ginger.

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 the 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.

References

- Aum Sarma, 2004. Mechanisation for major oil seeds and cereals in dry lands, winter school on mechanisation of dryland agriculture, CRIDA, Hyderabad. pp;363-371.
- Behera, B.K., S. Swain and S.K. Mohanty, 2007. Ergonomic evaluation of push-pull type weeders with women operators. *Journal of Agricultural Engineering* vol. **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
- Neetu Sharma, 2002. Perception of farm women about feasibility of drudgery reducing farm implements. *Annals of biology*. Vol. **18**(2); pp:209-210.

Shirahatti, S.S., Ayyanagowdar, M.S. and Polisgowdar, B.S., 2007, Computer based water allocation to water users' associations- a model for water management officials, *Karnataka Journal of Agricultural Sciences*, 20(2) 335-337

Singh S.P. and L.P. Gite, 2007. Ergonomical evaluation of a hand operated paddy winnowing by women workers. *Journal of Agricultural Engineering*. Vol **44**(4): 67-71.

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

Suman Singh, Puja Mathur and Madhu Rathore, 2007. Weeders for drudgery reduction of women farm workers in India. *Journal of Agricultural Engineering* vol. **44**(3); 33-38.

<http://www.solutionexchangeun.net.in/ictd/cr/cr-se-ictd-food-08070901.pdf>