



Review Paper

Research and Development in Indian Agricultural Technology: With Special Reference to Women

Suramya Joshi and Vashima Veerkumar

Department of Family and Community Resource Management, The Maharaja Sayajirao University of Baroda, Vadodara, Gujarat, INDIA

Available online at: www.isca.in, www.isca.me

Received 18th October 2013, revised 25th November 2013, accepted 18th December 2013

Abstract

Women are the backbone of agricultural workforce and a vital part of Indian economy. Over the years, there is a gradual realization of the key role of women in agricultural development and their contribution in the field of agriculture, food security, horticulture and other allied sectors. Ergonomics as a field aims at fitting the job to man. The target is always to maximize work output and comfort while minimizing health hazards. The new innovation in agriculture technology enhances the workers' comfort and adds to the safety.

Key words: agriculture, women, tools and equipments.

Introduction

Women in India play a major role in shaping the economy of the country. The women work force in agriculture and allied sectors is estimated to be around 92 million which amounts to 40 per cent of the total rural workers in the country¹. Studies have shown that the Indian women work upto 14 hours a day to carry out the most arduous activities on farm and at home. The technological development and transfer programmes are generally carried out on the assumption that the technologies are either gender neutral or that the men are the main users and decision makers. This is often incorrect because women have quite different technological needs than men due to their different ergonomical characteristics, level of education, experiences, skills and gender related factors. Due to this many programmes have been proved to be ineffective as the technologies developed are not relevant to the needs of women as the users. The rural women are employed to perform arduous field operations like preparatory work for seed bed, sowing behind the plough, transplanting, weeding, interculture, harvesting and threshing and primary processing of agro produce. The activities in agro- processing involve cleaning/grading, parboiling, milling, grinding, decortications and storage. Women workers are also preferred in commercial agriculture like tea, coffee, sugarcane, cotton, tobacco and plantation products². Researches have been conducted in India on women agriculture with the focus on farming activities and in the present paper the presentation has been made as per the activities.

Sowing Hand ridger was developed and evaluated by National Research Centre for Women in Agriculture (NRCWA) Sub Centre, Central Institute of Agricultural Engineering (CIAE) Bhopal (figure-1). It was developed for making ridges in field to sow vegetables on ridges. The equipment can also be used for

making furrows in field for irrigation. It was found that about 67 per cent saving in cardiac cost of worker per unit output was found with the ridger in comparison to the traditional method of making ridges. It has been found helpful in avoiding bending posture which is generally adopted in traditional method with short handled tools for making ridges as well as productivity of workers was found to be doubled with the equipment than traditional practice². Seed treatment drum (figure-2) is commercially available but was evaluated by National Research Centre for Women in Agriculture (NRCWA) Sub Centre, Central Institute of Agricultural Engineering (CIAE) Bhopal for mixing of chemicals in seeds for its treatment before sowing. It was found that no saving was there in cardiac cost of worker per unit area of output with the equipment in comparison to the traditional practice but this equipment provides safety to the worker as direct contact with chemicals is avoided. It also avoids bending / squatting posture which is ergonomically not worker friendly as done in traditional method of treating the seed².



Figure-1
Hand Ridger



Figure-2
Seed Treatment



Figure-3
Four Row Paddy Drum Seeder



Figure-4
Two Row Rice Transplanter

Four row paddy drum seeder (figure-3) developed by Tamil Nadu Agricultural University (TNAU) Coimbatore was evaluated by National Research Centre for Women in Agriculture (NRCWA) Sub Centre, Central Institute of Agricultural Engineering (CIAE) Bhopal and Tamil Nadu Agricultural University (TNAU). It has been found to be light in weight and easy to transport and handle. It aids in uniformity in seed sowing. Seed sowing is achieved with the equipment as compared to the traditional method. The two row rice transplanter has been developed by CRRI Cuttack and evaluated by National Research Centre for Women in Agriculture (NRCWA) Sub Centre, Central Institute of Agricultural Engineering (CIAE) Bhopal and Bhubhneswar for transplanting 20-25 days old mat type rice seedlings at 3-4 leaves stage in the two row simultaneously under puddled conditions (figure-4). Findings revealed that it saves upto 16 per cent cardiac cost of workers per unit of area and avoids bending

posture. Line sowing helps in promoting the use of mechanical weeders thereby reducing drudgery and cost during weeding operation. Productivity of the worker is found to be increased by 79 per cent compared to traditional method².

Four row transplanter for transplanting (figure-5) 20-25 days old mat type rice seedlings at 3-4 leaves stage in four rows simultaneously under puddle conditions was developed by CRRI Cuttack, and evaluated by National Research Centre for Women in Agriculture (NRCWA) Sub Centre, Central Institute of Agricultural Engineering (CIAE) Bhopal and Orissa University of Agricultural and Technology (OUAT) Bhubhneswar. The findings have revealed that about 61 per cent saving in cardiac cost of workers per unit of area. It avoids bending postures which is adopted in traditional method. Productivity of worker is increased by 79 per cent as compared to traditional method 2. CIAE seed drill developed by Central Institute of Agricultural Engineering (CIAE) Bhopal and refined by National Research Centre for Women in Agriculture (NRCWA) Sub Centre was evaluated at National Research Centre for Women in Agriculture (NRCWA) Sub Centre, Central Institute of Agricultural Engineering (CIAE) Bhopal (figure-6) for sowing seeds of wheat, soybean, maize, gram, pigeonpea etc. The findings revealed that output was increased by 18 times than traditional practice. About 87 per cent of cardiac cost was saved on per unit of output².



Figure-5
Four Row Rice Transplanter



Figure-6
CIAE Seed Drill



Figure-7
PAU Seed Drill



Figure-8
Naveen Dibbler

Punjab Agricultural University (PAU) Seed Drill developed for row sowing of wheat seed was developed by PAU Ludhiana and refined and evaluated by National Research Centre for Women in Agriculture (NRCWA) Sub Centre, Central Institute of Agricultural Engineering (CIAE) Bhopal (figure 7). It is found to be saving 87 per cent of cardiac cost of workers per unit of output. It is helpful in avoiding bending posture and it helps in increasing the output by 18 times than with the traditional tool². Naveen Dibbler (figure 8) for dibbling bold (like maize, soybean) or costly/ scarce seeds in less area and for gap filling purpose was developed by CIAE Bhopal and Evaluated at National Research Centre for Women in Agriculture (NRCWA) Sub Centre, Central Institute of Agricultural Engineering (CIAE) Bhopal is found to be helping in avoiding bending posture which is generally adopted in traditional method. It saves 13 per cent of cardiac cost of workers per unit of output with the dibbler as compared to traditional one².

Fertilizing: CIAE Fertilizer Broadcaster (figure 9) developed for uniform application of granular fertilizer in field. It has been found to be saving 6 per cent of cardiac cost of worker per hectare with refined broadcaster in comparison to traditional practice. It aids in uniform application of fertilizer as well as

saves the worker from dust of urea at the time of application thereby enhancing safety of workers. The productivity of the worker is found to be increased by more than thrice with the equipment than with traditional method. Tamil Nadu Agricultural University (TNAU) Fertilizer Broadcaster (figure 10) is a modified version of a commercially available fertilizer broadcaster. The back portion of the hooper is provided with a cushion pad. The lid is made transparent so that the worker can see the fertilizer in hooper². To study the musculoskeletal disorders of the farm women while performing the top dressing of fertilizer activity Hasalkar et al. 11 conducted a research. Thirty subjects with normal health without any major illness of an age group between 24-45 were selected. Majority of the sample belonged to good category of physical fitness. Very severe and severe pain in shoulder joint, upper arm, lower back, wrist/hands and knees were reported since they had to carry the basket filled with 4-5 kg of fertilizer either in hands or tie the bag on the waist. The fertilizer load in this method of application was directly transferred to the backbone. Reduction in the percentage of women complaining about the musculoskeletal disorders was observed with the use of improved fertilizer broadcaster.



Figure-9
CIAE Fertilizer Broadcaster



Figure-10
TNAU Fertilizer



Figure-11
Trishul Weeder



Figure-12
Twin Wheel Hoe



Figure-13
Cono Weeder

Weeding Trishul weeder was developed and tested in 2005-06 for the purpose for facilitating performing weeding activity in the standing position for deducing musculoskeletal disorders (figure 11). This technology was found acceptable in terms of stress factor, work output, tool factors and field acceptability. Field trials have revealed that output of this weeder was 94 per cent more than the traditional khurpi but it needed higher efforts resulting in increased heart rate per unit time³. Twin wheel hoe (figure 12) is used for weeding and interculture in upland and row crops in black soil region. It was developed by Central Institute of Agricultural Engineering (CIAE) Bhopal and evaluated by National Research Centre for Women in Agriculture (NRCWA) Sub Centre, Central Institute of Agricultural Engineering (CIAE) Bhopal. It was found that with

the use of this equipment, about 43 per cent cardiac cost is saved per unit. It aids in avoiding bending /squatting postures. Productivity of the workers was found to be increased by more than three times with the equipment than with the traditional method. Cono weeder (figure 13) developed and tested by TNAU, Coimbatore is used for uprooting and burying of weeds in between standing rows of rice crop in wetlands. It was found that it helped in avoiding bending posture thus reducing the drudgery of workers in weeding operation as well as increase in the output³.

Kishtwara and Rana 4 conducted a research on drudgery of hill farm women due to weeding activity. The objectives were to assess the health status of mountain women involved in weeding activity. To measure the ergonomic cost of weeding activity in terms of physiological cardiovascular stresses and to study the musculoskeletal problems of women workers involved in this activity the study was conducted in Kangra, Himachal Pradesh. Thirty respondents actively involved in weeding were selected. Two weeders were developed and designed by the AICRP - FRM research team. Two weeders having different specifications were given to the hill farm women on trial. Both the weeders were liked by the women for use but Weeder II flat type was found to be more suitable by the farm women. Weeder I prong type was helpful in loosening the soil whereas Weeder II flat type was helpful in taking weeds out from the roots. Weeder II flat type was light in weight and that is why it was much preferred over by traditional khurpi. Significant reduction was found in the average heart rate and energy expenditure of the respondents while working with the improved tool that is flat weeder II. Much less pain was reported by use of improved tool as compared to the work done with the traditional one. Significant reduction in pain was found in wrist/hands, ankles/feet and lower arm while working with the improved method over the traditional method.

Harvesting: For carrying out the activity of harvesting in the correct posture and reducing the drudgery, many technologies have been developed for women laborers. Finger Guard (figure 14) was developed by Acharya N.G. Ranga Agricultural University (ANGRAU), Hyderabad in 2009-10 to reduce the occupational health hazards. The guard covers the thumb and index fingers, it is simple to fabricate and is made of durable metal. In the conventional method of nipping without protective guards, skin ruptures were observed and workers also experienced pain at the finger tips. The guard is found to be saving labour time upto 37.5 per cent as the pace of work improved. Its saving time was 0.68 hours/acre of flower plucking. Drudgery was reduced moderately to an extent of 19 score against 30 maximum. User satisfaction and adoption rate was 84 per cent and 34 per cent. Ring cutter (figure 15) was developed in the year 2007-08 in Ludhiana for vegetable plucking. It is made up of high carbon steel blade with aluminum ring. This tool was compared with traditional and ordinary knife on the basis of standard ergonomic parameters (heart rate, energy expenditure, cardiac cost of work and grip strength). The results showed that with the help of newly developed tool that is ring cutter, heart rate, energy expenditure

and total cardiac cost of work was reduced as compared to the traditional tool. It was also found that low efforts were required and thus it increased the work efficiently which improved the work output. Tea leaves plucking kit (figure 16) was developed in Palampur in 2001-02 year to use for plucking and transportation of tea leaves. The kit includes a kitta with detachable umbrella, water proof dress, finger blades and wrap around. The results revealed significant decrease in physiological cost of work and increase in per capita output by using improved technologies. The use of improved tools and protected fingers, reduced cuts, injuries and muscular pain. Kishtwaria et al, (2004)⁵ conducted a research on women workers involved in tea plantation in Kangra, Himachal Pradesh. Their aim was to study the socio personal and physical characteristics and physiological workload of women involved in tea plantation work. Eighty women employed since 12-28 years were selected. The results of VO₂ max revealed that people of larger body have high VO₂ max which declines more with the age. Majority of the respondents were ectomorph. Age, heart rate values of the respondents (average and peak) were positively and significantly correlated in elder age group. Mittens for vegetable harvesting was developed in Parbhani in 2011-12 for vegetable harvesting activity (figure 17). The technology is helpful in reduction of physiological cost of work, body discomfort ratings and health hazards while harvesting manually. It has increased the work output and reduced drudgery of workers involved in harvesting activity of okra and brinjal³.



Figure-16
Tea Plucking Kit



Figure-17
Mittens



Figure-14
Finger Guard



Figure-18
Cotton Picking Apron



Figure-15
Ring Cutter

Cotton picking apron (figure 18) developed in Parbhani in 2004-05 for reducing drudgery, injuries and musculoskeletal disorders due to cotton picking. It is provided with long sleeves to prevent the body from direct sunlight exposure as well as to prevent the skin from scratching while moving into the field. There was a reduction of 77 beats in the total cardiac cost of work. To study the physiological responses during cotton picking activity performed by rural women of Bhatinda a study was undertaken by Kaur et al.,⁶. Sixty rural women in the age group of 21-45 years were selected. Two methods of plucking were assessed and compared namely with finger tips and with plucker. It was revealed that during combination of both techniques there was a decrease in energy consumption. Cot bag/ pick bag (figure 19) developed in Hisar in for picking cotton and vegetables. It wraps

uniformly and is evenly distributed over shoulders and waists. Length of the bag is above the knee which aids the women farmers in comfortable working, it also is convenient in emptying the pick bag. There is reduction in grip fatigue by 50 per cent of pain in wrist, upper back and shoulders. Earred cutter (figure 20) for jowar harvesting developed in Parbhani in 2005-06 for reducing musculoskeletal disorders involved injuries. It was found that with the technology, frequency of postural change and angle of deviation at cervical region was reduced³. Improved sickle (figure 21) was developed by Central Institute of Agricultural Engineering (CIAE), Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth (Dr. BSKKV) Dapoli and evaluated at National Research Centre for Women in Agriculture (NRCWA) Sub Centre, Central Institute of Agricultural Engineering (CIAE) Bhopal. It can be used for harvesting wheat, rice, soybean, chickpea, grasses and thin stalked crops. It is found to be essential in saving 15 per cent cardiac cost of workers per unit output with improved sickle. It also provides safety to the workers due to its better construction².



Figure-19
Cot bag/pick bag



Figure-20
Earred Cutter



Figure-21
Improved Sickle

Cotton Stalk Puller (Wheel type) developed and tested in TNAU, Coimbatore (figure 22). It is used for uprooting cotton plant stalks from soil. The heart rate while using this tool is 125 beats/min. it helps in avoiding bending posture thus reducing drudgery and chances of backache of workers in cotton stalk pulling operation. Cotton Stalk puller (Jaw type) was evaluated by National Research Centre for Women in Agriculture (NRCWA) Sub Centre, Central Institute of Agricultural Engineering (CIAE) Bhopal and Marathwada Agricultural University (MAU), Parbhani (figure 23). It is used for uprooting cotton plant stalks from soil. It is found to be reducing the excessive heart rate of the worker. It also helps in avoiding the bending posture and backache. Sugarcane stripper (figure 24) was developed by IISR Lucknow and refined by Orissa University of Agricultural and Technology (OUAT) Bhubhneswar and evaluated by Orissa University of Agricultural and Technology (OUAT) Bhubhneswar. It is used for stripping the leaves of sugarcane. The work output was found to be increased and there was reduction in excessive heart rate. Fruit harvester (figure 25) for plucking fruits from orchid trees was developed by Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth (Dr. BSKKV), Dapoli and evaluated by Tamil Nadu Agricultural University (TNAU) Coimbatore and CIAE, Bhopal. It helps in avoiding damages to the fruits. The operation of fruit harvesting is made safer as the worker does not have to climb on the trees and thus reducing the chances of injury².



Figure-22
Cotton Stalk Puller (Wheel Type)



Figure-23
Cotton Stalk Puller (Jaw Type)



Figure-24
Sugarcane Stripper



Figure-25
Fruit Harvester

Researches on uprooting and cutting tasks of hill women was conducted in 2007 at Palampur India with an objective to ascertain the physiological stress. Thirty respondents were selected for the study. BMI, body temperature, physical fitness index, lean body mass, body composition and Oxygen consumption were assessed for health status. Heart rate, energy

expenditure, total cardiac cost of work and physiological cost of work were also assessed. Majority of women were found of ectomorph body type. According to the compiled AICRP report (1996-2001), heart rate, energy expenditure were highest for uprooting of seeding, harvesting and bundling of crops. It was found that there was significant reduction in average and peak heart rate of respondents while working with improved tools for carrying out the activity of cutting and uprooting. There was reduction in the total cardiac cost of work and physiological cost as well as in the musculoskeletal problems. The work output was found to be increased with the use of new improved technologies⁷.

Singh and Sharma⁸ conducted a research on dissemination of ergonomically developed sickles. Three sickles namely 1) traditional farm implements used for harvesting and cutting by farm women, 2) improved sickle developed by Pant University and 3) Naveen Sickle by CIAE Bhopal were assessed. Seven farm women engaged in harvesting work were selected on the basis of similar age group, body type and free from chronic illness. Grip strength of each respondent was recorded before and after the performance of activity. The results indicated that Paired comparison of heart rate at various intervals for traditional sickle, Naveen sickle as well as Pantnagar sickle was found significant. The findings also revealed that when percentage decrease in grip strength was measured before carrying out the activity it was found non significant for the decrease in grip strength in each sickle for left hand but found significant for the decrease in grip strength in each sickle for right hand. Depending upon the findings of various ergonomic parameters final recommendation for micro level situation is Naveen sickle developed by CIAE Bhopal. Ergonomic evaluation of sickles for paddy harvesting by female agriculture workers was conducted by Dewangan et al. (2007)⁹. Eleven representatives (female agricultural workers) with an average 5 years of field experience of paddy harvesting were chosen. For ergonomic evaluation one local sickle and two improved sickles namely the Vaibhav and Naveen were selected. It was revealed that the average area of crop harvested per unit time was minimum with the local sickle and the field capacity with the Vaibhav sickle and the Naveen sickle was higher than the local sickle. Increase in heart rate per unit area during covered harvesting of paddy was minimum with the Naveen sickle whereas increase in heart rate per unit area covered was maximum with the local sickle. Increase in energy expenditure rate per unit area harvested was minimum with the Naveen sickle, followed by Vaibhav sickle and the local sickle. The study also revealed that maximum of discomfort in Borg (CR-10) was observed at lower back followed by the right shoulder with the local sickle, the Vaibhav sickle and the Naveen sickle respectively.

Threshing: Pedal Operated Paddy Thresher (figure 26) was developed and evaluated by OUAT Bhubhneswar for threshing of paddy. It is found to be helpful in reducing the drudgery involved in paddy threshing operation as bending posture is avoided and arms are not to be raised above shoulder height as in case of traditional method that is beating on a platform/stone.



Figure-26
Pedal Operated Paddy Thresher



Figure-29
Groundnut Stripper



Figure-27
Groundnut Decorticator (Sitting Type)



Figure-30
Tubular Maize Sheller



Figure-28
Groundnut Decorticator (Standing Type)



Figure-31
Rotary Maize Sheller

Groundnut Decorticator (Sitting type) (figure 27) for separating kernels from groundnut pods developed by CIAE Bhopal, refined and evaluated by NRCWA Sub Centre was found to be saving 79 per cent of cardiac cost of workers per unit of output with the improved equipment as compared to the traditional one. The productivity of workers increased tremendously than traditional practice apart from safety of

workers. The reduction in drudgery with the equipment per kg of pods decorticated is to the tune of 74 and 79 in case of standing and sitting type decorticators, respectively. Groundnut Decorticator (Standing type) developed by CIAE Bhopal, evaluated by NRWCA Sub centre, CIAE Bhopal (figure 28) showed 74 per cent of saving in cardiac cost of workers per unit of output with the groundnut decorticator as compared to traditional practice. Groundnut Stripper (figure 29) for stripping groundnut pods from crop vines. It was developed and evaluated by TNAU Coimbatore. It was found that there was an increase in the output such that 350 kg of pods were obtained as against 200 kg pods/ day with the conventional stripping. Its use minimized stress at knees and avoided squatting posture. About 79 per cent of cardiac cost was saved of workers per unit of output with the groundnut stripper as compared to the conventional practice. Tubular maize sheller (figure 30) for shelling maize from dehusked cob was developed by CIAE, Bhopal and NRCWA Sub-Centre, CIAE Bhopal. It was found to be saving 15 per cent of cardiac cost of workers per unit of output in comparison to the traditional practice, the productivity of the workers was increased 1.6 times than traditional practice i.e. shelling with the help of sickle. Rotary Maize Shellers (figure-31) for shelling maize from dehusked cob. It is commercially available, evaluated by NRCWA Sub Centre, CIAE Bhopal. It was found that with the use the output is high and is suitable for the farmers growing large quantity of maize. About 32 per cent of cardiac cost was saved in comparison to the traditional practice. The chances of injury to fingers are eliminated with the use of this equipment².

Transportation:Head load manager (figure 32) was developed at Hyderabad ANGRAU. It was mainly developed for transporting manure, seeds, harvested grains, vegetables, fodder and biomass fuel from home, farm and handling of sand. The developed load manager is easy to wear, straps are aided for providing frame to fix in place at the back and it has a shoulder frame support at the shoulder muscles. Face protector (figure 33) developed by Gobind Ballabh Pant University of Agriculture and Technology (G.B.P.U.AandT.) in 2011-12 can be used while weeding. It is designed to reduce the risk of direct facial contact with sharp crop leaf edges, minute and hazardous dust particles and insects. It can also be used for harvesting and other agricultural processes. Load fetching trolley (figure 34) developed at Hisar in 2005 for transportation of dung. Dung transportation is the most drudgery prone activity in annual husbandry sector. To save time, energy and drudgery, a trolley with light weight sheet and wheels was developed. Revolving milking stool and stand (figure 35) developed in Parbhani in 2008-09 to reduce stress and strain while performing milking activity. This tool is found to bring significant reduction in physiological cost of work and body discomfort. Gopal khare (figure 36) was developed in Parbhani in 2007-08 for cleaning the animal shade³.



Figure-32
Head Load Manager



Figure-33
Face Protector

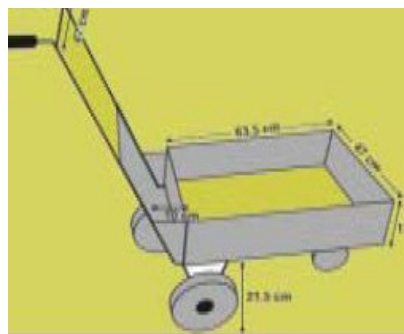


Figure-34
Load Fetching Trolley



Figure-35
Milking Stool



Figure-36
Gopal Khare

Doomra et al.¹⁰ conducted a research on cattle milking. Fifty women from each village who were actively involved in cattle milking were studied. Out of these 50 women, thirty (15 from each village) of average health status through physical fitness test were selected for the experimental work. Total cardiac cost of work, physiological cost of work and rated perceived exertion were determined for milking activity. The activity was perceived as moderately heavy in morning and heavy in evening. Intensity of musculoskeletal problems while performing the selected activity was recorded at a 5 point score varying from 1-5. It was found that the magnitude of discomfort was highest in upper arms. The grip strength was measured with grip dynamometer before starting the work and after completion of work. The percentage change for the right and left hand in the morning was 3.3 per cent and 3.5 respectively. Though in the evening it was 7.0 per cent and 7.4 per cent respectively. The grip muscles were found to be fatigued during performance of milking activity.

Summary: Women have been found to be involved in a variety of farm activities like sowing, weeding, harvesting, cutting and uprooting. The researches have aimed on developing women friendly tools for carrying out the various activities. The researches reviewed have been found to have concentration on increasing the work output and reduction in the drudgery. There are more than 50 improved hand tools/ manually operated equipments developed by various research organizations in the country.

Conclusion

It is a fact that women are the core of agriculture, there are now provisions being made for reducing the drudgery in agriculture so that there can be an increase in the work output. The tools and equipments developed are available at a very low cost. For example ring cutter costs 20 rupees, face protector 25 rupees and finger guard for 100 rupees. More and more researches are also being done to improve and modify the present tools. But there is an immediate need for intervention programme. Efforts

must be made for making the tools and equipments reach maximum women labourers across the country.

References

1. Pandey cited in Singh S.P., Gite L.P., Agarwal Nidhi and Majumdar J., Women friendly Improved Farm Tools and Equipment. Bhopal Central Institute of Agricultural Engineering, Bhopal, (2007)
2. Singh S.P., Gite L.P. Agarwal Nidhi and Majumdar J., Women friendly Improved Farm Tools and Equipment. Bhopal Central Institute of Agricultural Engineering, Bhopal, (2007)
3. Srinath K., Technologies for women in agriculture, Capital Business and Consultancy (2013)
4. Kishtwara J. and Rana A., Drudgery of Hill Farm women due to Weeding Activity, Proceedings of Humanizing Work and Work Environment, CIAE, Bhopal, 2, 42-49 (2007)
5. Kishwaria J., Awasthi K., Talwar N., Rana A. and Nayyar P., An Ergonomic Assessment of Women workers involved in Tea plantation in Himachal Pradesh, *Journal of Human Ecology.*, 16(3) (2004)
6. Kaur N., Dhillon M.K., Sidhu M. and Sandhu P., Physiological responses during cotton picking activity performed by rural women of Bhatinda District- Comparison of Conventional and Improved Method, Proceedings of Humanizing Work and Work Environment, CIAE, Bhopal, 2, 28-33 (2007)
7. Kishtwara J. and Rana A., Cutting and Uprooting Tasks of Hill Women: Stresses and Solutions. Proceedings of Humanizing Work and Work Environment, CIAE, Bhopal, 2, 34-42 (2007)
8. Singh S. and Sharma P., On Farm Trial (OFT) for Dissemination of Ergonomically Developed Sickles. Proceedings of Humanizing Work and Work Environment, CIAE, Bhopal, 2, 16-20 (2007)
9. Dewangan K.N., Owary C., Gogoi G. and Gorate D.U., Ergonomic Evaluation of Sickles for Paddy Harvesting by Female Agricultural Workers. Proceedings of Humanizing Work and Work Environment, CIAE, Bhopal, 2, 58-63 (2007)
10. Doomra Z., Singh K., Mehta M. and Dilbagi M., Cattle Milking- A Strenuous Activity Performed by Rural Women, Proceedings of Humanizing Work and Work Environment, CIAE, Bhopal, 2, 3-7 (2007)
11. Hasalkar S., Shivali R. and Budhidh R. Musculoskeletal disorders of the farm women while performing the top dressing of fertilizer activity, *Journal of Human Ecology.*, 16(3) (2004)