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Research Achievements of
AICRPs on Agricultural
Engineering

Indian Council of Agricultural Research
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Krishi Anusandhan Bhavan, New Delhi-110012

Contents

S.No.	Project	Page No.
1	AICRP on Application of Plastics in Agriculture	3
2	AICRP on Ergonomics and Safety in Agriculture	7
3	AICRP on Farm Implements and Machinery	10
4	AICRP on Post Harvest Technology	14
5	AICRP on Renewable Sources of Energy for Agriculture and Agro-based Industries	19
6	AICRP on Utilization of Animal Energy	26

All India Coordinated Research Project on Application of Plastics in Agriculture

1. **Title of the Project** : All India Coordinated Research Project on Application of Plastics in Agriculture
2. **Name and Address of the Project Coordinator** : Dr. Pratap Ray Bhatnagar, Project Coordinator (APA), Central Institute of Post Harvest Engineering and Technology, Ludhiana – 141 004.
Phone : 0161-2301673
Fax : 0161-2301673
Email: pr_bhatn@yahoo.com
3. **Research Achievements (New varieties/Technologies Developed/validated and being practiced in the last five years):**

ACHIEVEMENTS OF AICRP ON PHT

3.1 Tarfelt covered LDPE film lined tank

In order to store the water in upland areas of hills, a technology has been developed to construct LDPE film lined ponds with tarfelt covering. The tarfelt covering has been introduced to protect the LDPE film against photodegradation in presence of UV rays in sunlight, and small physical damages. It is an cheap and effective alternative material for the film covering as the earlier recommended stone covering is difficult due to non-availability of the boulders in uplands and restrictions on mining.



LDPE film (200 / 250 micron thick), 2 mm thick tarfelt sheet, pipe outlet, earth work are required for construction of this plastic lined tank. Depending upon the size of terrace available, inflow and water demand in the command. In view of the mid-hill conditions of NW Himalaya, the recommended capacity of tank would be 20-100 m³.

These tanks are of useful for storing water from runoff or low discharge springs for limited irrigation for vegetable / orchard crops, in providing supplemental irrigation and life saving irrigation during long dry spells to cereal / pulses. The studies of 30 such tanks at VPKAS, Almora revealed that the impact of these tanks are major as the productivity of crops particularly vegetable were increased to 14.7, 27.3, 21.1, 27.8, 21.4, 16.7 % for frenchbean tomato, vegetable pea, cabbage, potato and capsicum respectively. The unit cost: is Rs. 15,000 for 100 m³ tank.

3.2 Portable FRP Carp Hatchery

This portable FRP carp hatchery has been designed for carp fish breeding and hatchery rearing of seed. In one cycle 1.0-1.2 million carp seed (spawn) can be produced in the hatchery unit.

The system consists of Breeding/ spawning pool, hatching/ incubation pool, egg/ spawn collection chamber and overhead storage tank/ water supply system. The breeding pool is cylindrical water pool with bottom having a uniform slope towards outlet at the center. It has enough provision to provide water circulation / flow using PVC pipes fitted at the bottom of the side walls, and showers at the top to sprinkle and aerate the water. It is suitable for breeding 10-12 kg of carps in field conditions. Eggs/ Spawn Collection Tank is a rectangular tank with cotton inner lining for collection of eggs/ spawn from breeding/incubation pool. The cylindrical hatching pool consists of egg incubation chamber, FRP inner chamber, water supply system and accessories. Duck-mouths are fitted at the bottom of the pool for required circulatory water flow for the eggs and provision for drainage and cleaning is made in the design.



Hatchery of one million-spawn production means one breeding pool associated with one hatching pool. Similarly hatchery for two million capacity means one breeding pool with two hatching pools and three million capacity includes one breeding pool with three hatching pools. In the case of one, two and three million spawn capacity hatcheries 1.0-1.2 million spawn can be harvested in 4th, 2nd and everyday respectively.

The system is suitable for breeding of the Indian Major Carps viz., Rohu (*Labeo rohita*), Catla (*Catla catla*), Mrigal (*Cirrhinus mrigala*), Kalbasu (*Labeo calbasu*); Chinese carps viz., Silver carp (*Hypophthalmichthys molitrix*), Grass carp (*Ctenopharyngodon idella*), Common carp (*Cyprinus carpio*); and medium carps like *Puntius* sp. and *Labeo bata*.

The system is designed for fish breeding in the field conditions for 10-12 kg of carps in one operation. In one run 1.0-1.2 million spawn can be produced from the system. This quantity of spawn can be used as stocking material for 30 hectare of water area for fish production. In lean season the system can be used for ornamental fish rearing or common carp breeding or water storing. This hatchery can be used as a tool for fish biodiversity conservation also. The unit can be operated by unemployed youth, Gram panchayat and Cooperative Society on self-operational / rental basis. The hatchery has many advantages like: easy to transport, installation in less space, low water requirement, easy to repair and maintenance.

Presently the cost of one hatchery unit (one breeding pool, one hatching pool, one egg/ spawn collection tank, and fittings & fixtures of respective pool/ tank) is Rs 99,375/= only.

3.3 Pedal operated paddy thresher (VL Paddy Thresher 1)

In this thresher, the GI sheet body of the pedal operated paddy thresher was replaced by polycarbonate sheet of 1 mm thickness that reduces the total weight of the machine to 40 kg from 65 kg besides better look. The machine provides better ergonomics and reduces the probability of injury hazards by minimizing the sharp edge of metal during transportation and operation in hilly terrains. The plastic body has another advantage of being rust proof. The machine provides the threshing efficiency as 98%.



One man/woman can operate the machine and the output capacity of the machine is 80-100 kg/hr at 98 % efficiency. The machine is light (weight is 40 kg) and hence can be transported to different field particularly in hilly terraced land. The use of this machine significantly reduces the drudgery of hill farmers. The machine costs Rs 3500/-.

3.3 Orifice Meter

This equipment could be used for fertilizer application through drip irrigation system at low-pressure head and minimum pressure drop.

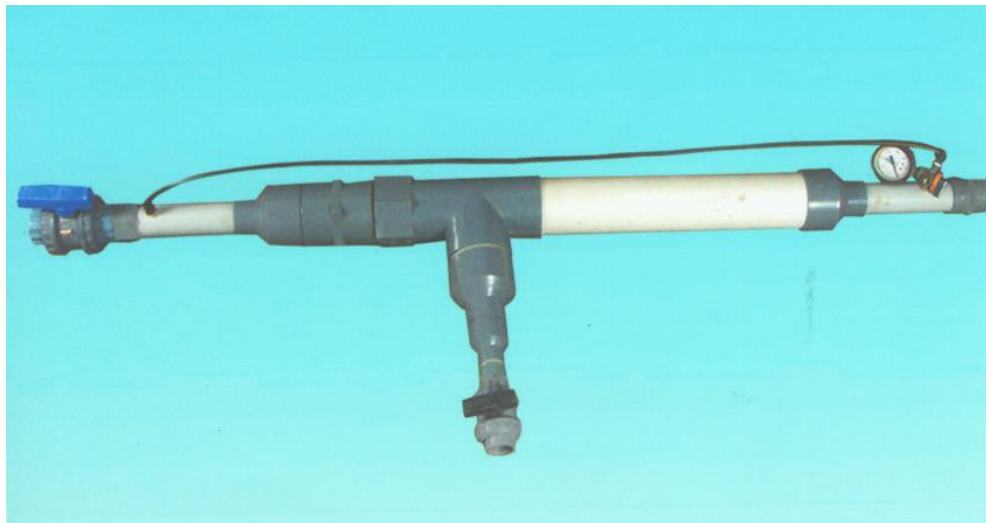


Developed orifice meters provide flexibility of applying fertilizer at different rates. Equipment operates at a pressure of less than 1 kg/cm^2 . While the venturi operates at 1 kg/cm^2 to 4 kg/cm^2 . The orifice meter having thickness-12.7 mm and diameter-3.18 mm is best with maximum fertilizer application rate 45 lph at inlet pressure 0.702 kg/cm^2 . The orifice meter is cheaper than most commonly used device i.e. venturi. The cost of orifice meter with by-pass

system is around Rs. 300.00 where as the cost of the venturi is Rs. 1048.00 for same purpose of fertigation. Fertilizer injection rate increases with increase in area of fertigation and decreases with increase in outlet pressure for particular inlet pressure. It requires only 0.5 to 1.0 HP motor for its operation. The orifice meter having thickness-12.7 mm and diameter-3.18 mm is best with maximum fertilizer application rate 45 lph at inlet pressure 0.702 kg/cm². The developed equipment is mainly suitable for farmers having less land holdings or in green houses/ net houses who want to apply fertilizers/ micro nutrients through drip irrigation system. The cost of orifice meter with by-pass system is around Rs. 300.00 where as the cost of the venturi is Rs. 1048.00 for same purpose of Fertigation

3.5 Low cost screen filter for micro irrigation system

Low head drip irrigation system used on small land holding to avoid the clogging of emitters in the system by filtering the irrigation water. Filtering unit is one of the important components of micro irrigation system which prevents clogging of emitters. It is more costly than other components of the system. To reduce the system cost, the efforts has been made to develop the low cost filter especially for smaller area, so that small and marginal farmers can effectively use the low cost micro irrigation system for different crops. The low cost screen filter for a low to medium capacity was developed with back wash flushing system. The PVC pipe of 90 mm and 50 mm diameter were used for fabricating the filter. The PVC pipe of 50 mm diameter used as filtering house and 90 mm diameter PVC pipe used as casing for the filter. The removal efficiency was found to be 36.8 % at sediment concentration of 250 mg/lit where as it was 71.9 % for sediment concentrations of 1000 mg/lit. The removal efficiency for higher sediment concentration was found more than lower sediment concentration. The clean pressure drop across the filter was found 1.2 m. It can be performed better in combination with the sand filter, which improves the filtration efficiency.



The Output capacity is 3-7 m³/hr. The developed filter is cost effective as it reduces the cost of the filter to 35-40 % compared to the standard screen filter available in the market. A local artisan can easily fabricate the developed filter. This filter is energy efficient and can be effectively used for low head drip irrigation system in smaller area. It costs Rs.782/-

All India Coordinated Research Project on Ergonomics and Safety in Agriculture

1. **Title of the Project** : **All India Coordinated Research Project on Ergonomics and Safety in Agriculture**
2. **Name and Address of the Project Coordinator** : **Dr. L. P. Gite**
Project Coordinator
AICRP on Ergonomics and Safety in Agriculture
Central Institute of Agricultural Engineering
Nabi Bagh, Berasia Road
Bhopal – 462038 (M.P.).
Phone : 0755-2747430
Fax : 0755-2734016
Email: lpгите@ciae.res.in
3. **Research Achievements (New varieties/Technologies Developed/validated and being practiced in the last five years):**

1. Agricultural safety

1.1 Periodical monitoring of agricultural accident data

- a) Small sample survey of agricultural accidents occurred in four states namely Madhya Pradesh, Tamil Nadu, Orissa and Punjab during 1995-1999 was carried out. From the data obtained, mean values for source wise percentage of accidents and accident incidence rates per 1000 machines were calculated. The accidents due to tractors were highest i.e. 24.5% followed by threshers 10.1%, sprayers 8.3%, chaff cutters 7.2%, electric motors and pump sets 3.5%. The accident incidence rates per 1000 machines were 24.1 for tractors, 13.9 for threshers, 4.4 for sprayers, 3.8 for chaff cutters, 1.1 for electric motors/pump sets and 18.9 for cane crushers. Based on the data collected, the number of accidents per 100,000 workers were estimated to be 200.4 whereas the number of fatalities were 21.2.
- b) As the small sample survey showed the seriousness of the agricultural accident situation, a large sample size survey was carried out in 2004-05 in Tamil Nadu, Madhya Pradesh and Orissa and in 2005-06 in Punjab. The data were collected from 240 villages each in Tamil Nadu, Orissa and Punjab, and from 360 villages in Madhya Pradesh. The mean values for no. of accidents per 100,000 workers were 1278 and the number. of fatalities per 100,000 workers were 12.4. On the basis of the data collected through survey, each centre has worked out a survey, package of safety measures for their respective states. The package consists of recommendation related to engineering, education and enforcement aspects and efforts are being made to promote these package of safety measures through State Govt. Agencies.

1.2 Status of adoption of safety measures on threshers

The PAU centre and TNAU centre have carried out studies on status of adoption of safety measures on threshers. It was observed that inspite of Dangerous Machine Regulation Act 1983 being in force since last two decades, a large number of threshers manufactured in these states do not meet the guidelines given by Indian Standard IS 9020-2002. Programmes have been undertaken to create awareness about the same.

1.3 Status of adoption of safety measures on chaff cutters

PAU centre carried out a study to know the status of adoption of safety features on chaff cutters in Punjab state. The study revealed that more than 70% of the chaff cutters did not have safety gadgets/provisions as given in Indian standards namely IS: 11459-1995 (Power operated chaff cutter) and IS 7898-2001 (Manually operated chaff cutter).

1.4 Safety gadgets for sugarcane crushers

TNAU centre adopted /developed safety gadgets for sugarcane crushers which include feed plate or feed chute as per BIS specification (IS 1973:1999, Sugarcane crusher-specifications), a tool for lubrication of the transmission system, and a hook for removing the bagasse from the sugarcane crusher outlet.

1.5 Farm safety promotion programmes

The ESA centres are regularly carrying out farm safety promotion programmes to create awareness amongst farmers and workers to minimize agricultural accidents. Slow moving vehicle emblem have been fitted on the rear of the tractors and at the rear of the tractor trolleys.

2. Anthropometric and strength data of agricultural workers for farm equipment design

Keeping into consideration the design requirements of hand tools, animal drawn equipment, tractors, power tillers, power operated machines, self-propelled machines and workplaces AICRP on ESA started a countrywide programme for collection and compilation of anthropometric and strength data of agricultural workers. Till date, anthropometric data on 79 body dimensions for 12525 agricultural workers and strength data on 16 parameters for 5937 workers have been collected. The mean stature and weight of Indian agricultural workers on the basis of data collected so far worked out to be 163.3 cm and 54.7 kg for male workers and 151.5 cm and 46.3 kg for female workers. The mean values for strength data in pushing and pulling by both hands in standing posture are 224 N and 218 N for male workers and 143 N and 158 N for female workers, respectively. All these data are being put in the computerized anthropometric and strength databank of agricultural workers created at CIAE Bhopal.

3. Anti-vibration devices for power tillers and tractors

The TNAU centre has developed anti-vibration devices for power tillers and tractors to minimize the vibration related occupational health problems of the operators. By the use of these devices the hand transmitted vibrations during work in power tillers could be reduced by more than 40% in rototilling as well as in transport operation. Similarly, with the use of tractor seat isolator, the reduction in whole body vibration varied from 12 to 42% during disc ploughing, 25 to 46% during cultivator operation and 70 to 83% during transport operation mode.

4. Modification / development of Ergonomically improved tools/equipment

The following equipment were modified and ergonomically evaluated. The output capacity has been increased by taking into account the anthropometric and strength data of the agricultural workers.

- **Sugarcane stripper (OUAT centre)**

Output : 49 kg /h as against 38 kg/h in traditional practice.

- **Diaphragm pedal pump(OUAT centre)**

Output : 4170 l/h as against 450 l/h in traditional practice.

- **Eight row paddy seeder (TNAU centre)**

Output : 0.12 ha/h. About 40 % saving in seed rate and 90% saving in cost and time when compared to transplanting.

5. Assessment /development of women friendly tools and equipment

AICRP on ESA deals with gender related technological issues. Therefore, identification, assessment and refinement of improved equipment suitable for farm women is one of the thrust areas of the Project. As a part of this programme ESA centres carried out ergonomical evaluation of 15 tools and equipment to assess their suitability to women workers and to refine the same for better productivity and comfort wherever necessary. Some of the important equipment modified to be used by the women workers and these are given below:.

- **TNAU Four row paddy seeder** (output: 0.014 ha/h)
About 40 % saving in seed rate and 60% saving in cost and time when compared to transplanting.
- **TNAU Groundnut stripper** (Output :44kg/h with four workers as against 25 kg/h in traditional practice),
- **TNAU Fertilizer broadcaster** (output: 0.76 ha/h workers as against 0.30 ha/h in traditional practice),
- **OUAT Pedal operated paddy thresher** (Output: 35 kg/h workers as against 30 kg/h in traditional practice and the discomfort due to bending and hand lifting is avoided),
- **OUAT sugarcane stripper** (output : 46kg/h workers as against 38 kg/h in traditional practice and the injuries are avoided),

6. Status of implementation of Dangerous Machine (Regulation) Act 1983

In 1983, the Parliament passed an act to provide for the regulation of trade and commerce in and production, supply, distribution and use of the product of any industry producing dangerous machines with a view to securing the welfare of labour operating any such machines and for payment of compensation for the death or bodily injury suffered by any labourers while operating any such machine, and for matters connected therewith or incidental thereto. In spite of passing of more than 20 years, this Act has been adopted by some states only. Therefore, correspondence was made with all the states to get information on implementation of the act. Perusal of the replies and the situation prevalent in different states indicate that in most of the states where the act is notified, it is in dormant stage. Considering this situation, various provisions of the act have been examined by us and modifications needed for better implementation were prepared and submitted to Deptt. of Agril & Cooperation of Govt. of India, for needful.

All India Coordinated Research Project on Farm Implements and Machinery

1. **Title of the Project** : **All India Coordinated Research Project on Farm Implements and Machinery**
2. **Name and Address of the Project Coordinator** : **Dr. Surendra Singh**
Project Coordinator (FIM)
Central Institute of Agricultural Engineering
Nabi Bagh, Berasia Road
Bhopal - 462 038
Phone: 0755-2733385 (O), 2732969 (R)
(M) 094244 81850; FAX: 0755-2734016
E Mail: ssingh5119@gmail.com, ssingh@ciae.res.in
3. **Research Achievements (New varieties/Technologies Developed/validated and being practiced in the last five years):**

Introduction

The role of improved farm implements and machinery, for sustainable development of agriculture and enhancement of productivity, has been established beyond doubt. They help to achieve timeliness of farm operations and enabling efficient use of other inputs such as HYV seeds, chemicals, fertilizer and water. Under dynamic situation of changing cropping patterns as influenced by local agro-socio-economic factors, identification of farm mechanization needs and development of need-based farm implements and machinery are of paramount importance.

For development, testing and popularization of need-based farm implements and machinery for different regions of the country, the All India Coordinated Research Project (AICRP) on Farm Implements and Machinery (FIM) was started by the Indian Council of Agricultural Research in 1975 during the V Five Year Plan with six Centres. Presently there are 23 Centres including power tiller centres, working on one or more of the five distinct activities under the Project namely, design and development, prototype manufacturing, prototype feasibility testing, front line demonstration and power tiller technology.

4. Achievements During X Plan Period

4.1. Tractor Mounted Rotary Tiller: Tractor Operated Rotary Tiller (also called Rotavator) is suitable for preparing seedbed in a single operation both in dry and wetland conditions. It is also suitable for incorporating straw and green manuring. Pulverizing of soil is more uniform and better because impact of revolving blades of rotavator shear the soil and make the soil fine. The use of a rotavator results in about 25-40% and 15-25% saving in the fuel consumption for paddy and wheat harvested fields, respectively as compared to the conventional tillage implements. It saves about 40-60% of time and 20-30% water through puddling. The cost of rotavator is Rs. 65,000/- and its field capacity is 0.25 ha/h. The cost of operation by conventional method is Rs. 2,700/- per hectare. Thus there is a saving of Rs. 1000-1500/ha (Rs. 1250/- average) in cost of operation.



4.2. Tractor mounted pulverizing roller attachment to tiller: Pulverizing roller attachment to cultivator with helical blades pulverizes the soil to a great degree and creates hardpan in the soil because of the impact of the blades on the soil. Tractor-drawn pulverizing Roller attachment for cultivator is mounted at the back of the cultivator and is used for puddling the soil quickly. The savings with this machine in fuel and time are 20-35% and 20-30%, respectively. Additionally, due to better puddling,



it saves 20-30 percent water requirement for paddy fields. The cost of machine is Rs. 4,500/- and field capacity is 0.4 ha/h. The cost of operation by conventional method is Rs. 2,700/- per hectare. There is a saving of Rs. 900/- per hectare in cost of operation over traditional method.

4.3. Manually operated low land rice seeder: During peak transplanting season, labour availability is scarce resulting in delayed transplanting with aged seedlings, which in turn affects productivity. To overcome this problem, pre-germinated low land rice seeder has been developed. The field capacity varied from 0.1 to 0.14 ha/h with labour requirement of 15-20 man-h/ha. The traditional method requires a total of 964-1000 man-h/ha. Cost of operation of the machine is Rs 135/ha as compared to Rs 205/ha by traditional method.



4.4 Tractor operated zero-till seed-cum-fertilizer drill: The zero-till seed-fertilizer drill was developed to sow wheat directly in rice-harvested fields without preparing the seedbed. The field capacity of the machine is 0.3 ha/h. The cost of operation by traditional method is Rs. 3,400/ha. The machine saves Rs 1500-3000/ha.



4.5. Tractor mounted raised bed planter: A bed-former-cum-seeder has been developed for sowing wheat. The machine can make three beds in single run and the width of each bed is adjustable (35 to 45 cm). A Planting attachment has also been made with the machine for sowing maize, groundnut, cotton etc on the beds. The field capacity of machine is 0.26 ha/h. The cost of operation is about Rs. 4500/ha as compared to conventional method (Rs. 3400/ha). The crop being sown on beds, it saves about 20-30% water and 20% seeds.



4.6. Tractor mounted inclined plate planter: The CIAE 6-row tractor mounted inclined plate planter has been adopted for sowing intercrop on broad beds and a bed shaping/forming attachment has been added as an integral part in the refined design of the planter. During field trials with three rows of soybean and two rows of Pigeon Pea at 300 mm row-to-row spacing, the field capacity is 0.42 ha/h with an effective width of coverage of 1850 mm. The cost of operation is Rs. 1280/ha as compared to Rs. 1560/ha by conventional method.



4.7. Self-propelled rice transplanter: It is suitable for transplanting paddy seedlings in puddled soils. Machine uses mat type seedlings and it can transplant 1.2-1.5 ha/day with the help of 5 persons by working at a speed of 1.1-1.5 km/h. It saves about 65% labour and 40% cost of operation as compared to manual transplanting. The cost of operation is Rs. 2,000/ha as compared to Rs. 3,000/ha by traditional methods.



4.8. Tractor operated Sett Cutter Planter for sugarcane: This machine cuts whole sugarcane in to pieces of uniform size, places the sets in the furrow prepared by ridger, covers the sets by soil and press the soil in one operation. Fertilizers and chemical can also be applied. The field capacity is 0.20 ha/h. The cost of operation of equipment is Rs. 2000/ha as against Rs. 3300/ha by traditional method.



4.9. Self-propelled power weeder: The machine is also useful in row crops, horticultural and vegetable crops. The average cost of weeding with power weeder is Rs 1000/ha. The speed of power weeder can be varied from 2.3-2.5 km/h and the field capacity is 0.10 to 0.13 ha/h. The equipment saves 90%



operating time and 33% in cost of weeding as compared to hand weeding by Khurpi.

4.10. Tractor operated aero blast sprayer: The sprayer is mounted on the tractor 3-point linkage and is operated by tractor PTO. Machine can cover about 1.7 ha/h at a speed of 1.5 km/h. Application of sprayer can be varied from 100-400 litres/ha depending upon different valve setting. Effective width of sprayer is found to be about 13.0-m distance. The cost of operation of this machine is Rs. 500/ha as against Rs. 700/ha by conventional method.



4.11. Self-propelled walking type vertical conveyor reaper: Self-propelled vertical conveyor reaper is used for harvesting cereal crops like wheat and paddy. It cuts the crop, conveys it vertically to one side and drops in a windrow for easy collection. The field capacity of the machine is 0.15 - 0.17 ha /h. Use of this machine results in saving of 90 –95% in labour, time and cost of operation as compared to conventional method. The cost of operation is Rs. 650/ha with this machine as against Rs. 2000/ha by traditional method.



4.12. Tractor mounted vertical conveyor reaper: The machine is mounted in the front of a tractor and is used for harvesting cereal crops like wheat and paddy. It cuts the crop, conveys it vertically to one side and drops in a windrow for easy collection. The field capacity of the machine is 0.4 ha/h when operated at forward speed of 2.5-3.5 km/h. The cost of operation is about Rs. 1000/- as against Rs. 2000/ha by traditional method.



4.13. Tractor mounted fodder harvester: Flail type mower-cum-chopper for fodder crop is capable of harvesting, chopping and loading of fodder crops such as maize, *bajra*, oats in a trailer, attached behind the machine. The capacity of the machine is 0.20 ha/h at a forward speed of 2.5-4.0 km/h. The cost of operation of this machine is Rs. 1500/ha against Rs. 2000/ha by conventional method.



4.14. Power operated axial flow sunflower thresher: The thresher has an axial flow system and the material flows parallel to the axis of the threshing cylinder. The machine is operated by 7.5 hp motor and has a capacity of 8.0 q/h clean grains. The threshing efficiency of the thresher is more than 99 percent. There is a saving of 85% in labour, 75% in time and 30% in cost of operation. The cost of operation of this machine is Rs. 450/t and Rs. 1000/t with conventional method.



4.15. Power operated maize dehusker-cum-sheller: Maize dehusker-cum-threshers namely spike tooth type (modified version of wheat thresher) and axial flow type (modified version of sunflower thresher) have been developed for threshing maize along with the husk. The percent recovery of grain with machine is 97 percent as compared to 78.4 % by manual threshing. There is a saving of about 60-70% in cost and about 90% in labour as compared to the traditional methods of dehusking and threshing. Cost of operation of this machine is Rs. 500/t against Rs. 1500/t by traditional method.



4.16. Tractor operated straw combine: Straw combine is used to recover wheat straw after combine operation and is operated by a tractor. Straw collected by straw combine is cut into pieces and collected in a trolley. The capacity of machine on an average is 0.4 ha/h while operating at a speed of 2.5km/h and straw recovery is about 55-60%. The cost of operation is Rs. 1200/ha. There is an additional grain recovery of 50-100 kg/ha.



4.17. High capacity multi-crop thresher: Mechanical threshing of crops has been adopted in Indian Agriculture in a big way. Power wheat threshers were introduced in 1960s in India. Threshers can so adjusted so that oil seeds and pulses can be threshed and damage and losses to the grains are minimized. Sometimes, concave needs to be changed. The grain output capacity is 16-20 q/h for wheat, 8-10 q/h for raya, 6-8 q/h for gram and 4-5 q/h for green gram. Threshing efficiency, un-threshed grain and visible damage are 98-99%, 1.5-2.0% and 1.0% respectively. Average total losses are about 5%. For moong crop, two cutting blades (out of four) need to be removed to reduce the damage. The average capacity of thresher is 4.0 q/h for moong and 5.0 q/h for guar crop. The breakage is less than 5.0% for moong and 0.5 to 2.0% for guar. Threshing efficiency and cleaning efficiency are with in the prescribed limit. The expenditure involved is Rs. 250-300/h. The net saving per year is estimated to be Rs. 86,000/- and the pay back period of machine is one year.



All India Coordinated Research Project on Application of Post Harvest Technology

1. **Title of the Project** : **All India Coordinated Research Project on Post Harvest Technology**

2. **Name and Address of the Project Coordinator** : **Dr S.K.Nanda**
Project Co-ordinator AICRP on Post Harvest Technology
CIPHET, Ludhiana-141 004
Phone: 0161-2308672(O)
Fax: 0161-2308670
E-mail: sk_nanda4578@sify.com

3. **Research Achievements (New varieties/Technologies Developed/validated and being practiced in the last five years):**

ACHIEVEMENTS OF AICRP ON PHT

Some of the significant achievements of AICRP on PHT Centres during **10th Plan** (2002-2007) have been classified and enumerated below.

3.1 POST HARVEST LOSS REDUCTION

- **Assessment of Post Harvest Losses**

Nationwide assessment of post harvest losses has been undertaken by all the centres under AICRP on PHT for 42 major crops/commodities from 12,000 farmers in 120 districts covering 14 agro-climatic zones through collection of data by enquiry as well as by observation. Sorting and analysis of collected data is currently in progress.

- **Popularization of 'TNAU insect trap'**

This is a simple and low cost probe to trap pests from stored food grains at domestic level, taking advantage of the wondering behavior of insects towards air pockets. The technology has been given to M/s K.S.N.M. Marketing, Coimbatore and so far about **1,50,000 traps have been sold** at a cost of Rs 45/- per unit.

- **Preservation of milky mushroom**

Process parameters for preserving milky mushrooms up to 18 months by canning in brine (3%) and in tomato pulp (4° Brix) were standardized by Coimbatore centre. The technology has been transferred to M/s Blue Hills Agrotech, Coimbatore who have submitted canned samples for quality clearance to export the product to Japan.

- **PKV mini dhal mill (modified)**

Versatility of PKV dhal mill from Akola Centre has been enhanced for polishing mold-affected sorghum and for cleaning wheat. The PKV dhal mill has been commercialized by transferring the design to 3 manufacturers.

During the 10th Plan period a total of **152 units were sold** (2 hp size :117 no., 3 hp size : 33 no. and 5 hp size : 2 no. for Rs 37000, Rs 63000 and Rs 65000, respectively). About 32 units of PKV dhal mills are also being used for sorghum demoulding and wheat cleaning.

- **Low-cost safe storage of pulses**

A two-stage pulse grain storage technology has been developed by Bangalore centre. This low cost method involves extended sun drying of freshly threshed pulse grains for 3-5 days and application of about 1" thick layer of coarsely sieved sand which are quite effective to remove the field infestation and cross-infestation of pulse beetles respectively.

The technology has been approved by the University and State Department of Agriculture, Govt. of Karnataka and included in the package of practices for Agricultural Crops, brought out jointly by the University and State Dept of Ag. The technology is under large-scale demonstrations in Karnataka by the Bangalore centre in close collaboration with KVKs and State Dept of Ag, and UAS, Dharwad.

- **Fruit and vegetable washing machine**

A stainless steel portable mechanical washing machine (power 1 hp, cost Rs 25000-50,000 for 100-600 kg/h capacity) has been developed and commercialized by PAU Ludhiana centre, suitable for a wide range of fruits and vegetables (carrot, potato, radish, turnip, ginger, okra, tomato, spinach, kinnow and pears). This machine could also be successfully used for breaking garlic bulbs and peeling potatoes. Technology commercialized to M/s Paradise Engg. Corp., Ludhiana and **10 pieces have been sold** by the manufacturer

- **Manually operated ice crusher**

A pedal operated ice crusher (cost Rs 15,000 and capacity 500-600 kg/h) has been developed by Raichur Centre to facilitate providing crushed ice for preservation of fish on board or at the landing centre.

3.2 VALUE ADDITION

- **Arecanut Dehusker**

It is a manually operated unit (capacity 160 kg per 8h, cost Rs 3000/-) and requires four persons for dehusking freshly harvested mature green areca nuts simultaneously. The technology was developed by Bangalore Centre and have been commercialized. About **44 units are already in use** in Karnataka, Tamil Nadu, Kerala and Orissa.

- **2-in-1 Maize Sheller-cum-Sunflower Thresher**

This gadget (0.5 hp-single phase motor, inter-changeable attachments for maize shelling and sunflower threshing, 100-120 kg of threshed grains per hour output, cost Rs. 6,000/-) has been developed by Bangalore centre, to cater the needs of small and marginal maize growers. Two persons can use it for shelling maize as well as threshing sunflower simultaneously.

The technology has been **transferred to more than 250 farmers** in Hassan and Chikmagalur districts and the unit is in great demand in Hassan and Shimoga districts of Karnataka.

- **Thresher - cum - pearler for millets**

Vivek thresher-cum-pearler (cost Rs 8500, threshing capacity 30-35 kg/h, pearling capacity 45-60 kg/h)

developed by Almora centre is suitable for threshing, dehusking and pearling of finger millets (*mandua*) and barnyard millet (*madira*).

This technology has been **commercialized**. **Four hundred twenty five units** of this machine costing **Rs 37,57,000/-** have been already sold to farmers, departments, NGO and others.

- **Value added products from cashew apple, pine apple, stone apple and custard apple**

Process technology have been standardized by Bhubaneswar centre for preparation of different value added products such as ready-to-serve (RTS) beverage, squash, jam and toffee etc from fruits such as cashew apple, pineapple, stone apple and custard apple.

- **Value added products from Jackfruit**

The process and protocol have been standardized by Bangalore centre for preparation of several value added products such as halwa, chips, candy, RTS beverage, squash, fruit leather, papad, pickles, bulb flour, seed flour from jackfruit bulbs and seeds. Processing of jackfruit into value added products would **enhance jackfruit growers' income by 2.5 to 6 times** more compared to fresh jackfruit.

- **Rasper for tuber starch extraction**

An improved industrial rasper (cost Rs 30,000 and capacity 320-360 kg/h) has been developed by Trivandrum centre for extracting starch from tubers such as cassava or tapioca, sweet potato, curcuma and arrowroot. Technology has been commercialized and **2 units have been sold**.

- **Garlic processing machines**

An improved garlic bulb breaking machine (cost Rs 11000, capacity 800 kg/h), a garlic clove flaking machine (cost Rs 11,000, capacity 420 kg/h) as well as a garlic peeling machine (cost Rs 10,000 for batch type and Rs 70,000 for continuous type, both capacities 15-22 kg/h) have been developed by Udaipur centre to remove the drudgery and mechanize these operations. First two prototypes have been transferred to **3 manufacturers each**.

- **Turmeric boiler for on-farm use**

A farm level turmeric-boiling unit (cost Rs 10,000, capacity 225 kg/batch) has been developed and popularized by Coimbatore centre, which reduces the water and fuel requirement (10 kg firewood/batch). The technology has been commercialized and transferred to 4 manufacturers.

- **Dehumidified air dryer**

A prototype dehumidified air dryer based on heat pump principle (cost Rs. 100,000 and capacity 25 kg/batch) has been developed by Bhubaneswar centre. The dryer is suitable for high value fruits, vegetables, spices and medicinal plants under low temperature and low humidity conditions to maintain quality.

- **Tender coconut punch and cutter**

A hand-operated tender coconut punch machine has been developed by Kasargod centre to save time and drudgery involved in cutting and preparing the tender nut prior to drinking its water, by using a straw through the punched hole. A coconut cutter (cost Rs 2500, output 20 to 30 nuts/min) has also

been developed by Kasargod centre to split open the tender nut into two halves.

- **Snow ball tender coconut making machine**

Technology and equipment for making snowball tender nut (SBTN) has been developed by Kasargod centre to facilitate consumption of tender coconut water along with the tender coconut kernel (cost Rs 25000, capacity 300 snow balls/8h).

- **Maize dehusker cum sheller**

A machine has been developed by Udaipur Centre for simultaneous dehusking and shelling of maize cobs in a single pass (cost Rs 50,000, capacity 800 kg cobs/h). The technology has been **transferred to 3 licensees** and **14 machines have been sold** at different places. The Government of India has declared a **subsidy equal to 25%** of the cost on purchase of this machine.

- **Triple pan furnace for making jaggery from sugarcane**

An improved triple pan furnace (cost Rs 65 000 and capacity 120 kg juice/h) has been developed by Lucknow centre for boiling and concentration of sugarcane juice. First two pans are for preheating the juice by flue gases before transferring the juice to the boiling pan, which improves the thermal efficiency and HUF.

- **Filtration and clarification technologies for sugarcane juice**

A mechanical sugarcane juice filtration system (cost Rs 24 000 and capacity 700 kg juice/h) has been developed by Kolhapur centre for cleaning the juice from very small particles (up to 500 micron size) and insoluble impurities in order to improve the quality of jaggery.

A technique for efficient clarification during jaggery making has been developed by Kolhapur centre by using okra plant stalk powder.

- **Electronic alarm for making jaggery from sugarcane**

A battery-operated electronic alarm (cost Rs 300) has been developed by Pantnagar centre to determine the striking point temperature (concentrated juice temperature of 116 °C) in jaggery making.

- **Value added products from sugarcane**

The process for making **liquid jaggery** (Rs 35 per kg) has been developed by Kolhapur centre. The product is suitable for utilization as sweetening agent in food, drinks and also for table purpose. The technology has been **transferred to 25 farmers-cum-processors**.

A **granular jaggery** (powder jaggery) making unit (cost Rs 10,000, capacity 100 kg/h) has been developed by Anakapalle centre having a recovery of 100 kg crystal jaggery from 1000 kg of cane. It can be used for table purpose like free-flowing sugar.

A process has been developed and standardized by Pantnagar centre for making **jaggery chocolate**, a novel confectionery product. Prepared from cocoa powder, milk powder, soy flour, butter and jaggery, it costs only Rs 5 per 50g piece of chocolate.

3.3 BY-PRODUCT UTILIZATION

- **Process technology for apricot kernel oil**

The process for extraction of apricot oil was standardized by Solan centre, comprising of mechanical decortication of apricot fruit stone, separation of kernels, followed by recovery of oil by expeller and filter press. Oil yield is about 122 litres (Rs 260 per litre) from 1000 kg apricot stones (Rs 15 per kg).

The complete technology has been recently **transferred to one SHG**. For technology demonstration and custom service to the local farmers, **4 apricot oil extraction units** have been established in 4 districts (Solan, Shimla, Kinnaur and Kullu) in HP.

- **Modified Chilli seed extractor**

Reciprocating sieve unit of the earlier prototype was replaced by a gyratory sieve (present capacity 100 kg chilli fruit per hour, cost Rs 38,500/-).

The technology has been transferred to a manufacturer and already **12 units have been sold** at a cost of Rs. 43,000/- per unit.

- **Hybrid (solar / biomass / electrical) dryer for coconut**

A coconut dryer has been developed by Kasargod centre to dry 1500 nuts/batch in 3 days (cost Rs 70,000). The dryer can use solar energy, electrical heaters and combustion of coconut husk and coconut shell, individually or in combination, as the source(s) for heating the air.

All India Coordinated Research Project on Renewable Sources of Energy for Agriculture and Agro Based industries

1. **Title of the Project** : **All India Coordinated Research Project on Renewable Sources of Energy for Agriculture and Agro-based Industries**

2. **Name and Address of the Project Coordinator** : **Dr Murari Shyam**
Project Coordinator
Central Institute of Agricultural Engineering
Nabibagh, Berasia Road, Bhopal – 462 038
Phone: 0755-2733383
FAX: 0755-2734016
E-mail: mshyam@ciae.res.in

3. **Research Achievements (New varieties/Technologies Developed/validated and being practiced in the last five years):**

3. Achievements during the Xth Plan Period

3.1 Solar tunnel dryer for Agro Industrial Applications

Natural convection walk-in type dryer useful for bulk drying of agricultural & industrial products at moderate air temperature. It consists of a hemi-cylindrical metallic frame of 3.75m diameter & 2.0m height and is covered with UV stabilized transparent polythene sheet of 200 micron thickness. Length of the dryer depends upon type and quantity of the product to be dried per batch. A slope of 10-15° is provided along the length of the tunnel. An exhaust fan at the upper end of the tunnel, along with two chimneys on the top of the tunnel are provided to remove the moist air. An insulated wall on north side is provided to reduce the heat loss. The structure for spreading the product is designed to match the drying characteristics of the product.

Around a dozen tunnel type solar dryers have been installed primarily in Rajasthan for various commercial applications including drying of dibasic calcium phosphate, gooseberries, hand made paper sheets, surgical cotton, rose petals, various spices etc. The average temperature inside the tunnel found 15-20°C higher than the ambient temperature. The moisture content of 1.5 ton of di-basic calcium phosphate is reduced to around 15% from an initial value of 35-40% in 2-3 solar days depending upon the solar insolation.

The cost of the dryer may vary depending upon application and size of the dryer. Approximate cost of materials and labour is around Rs 75,000 (US \$ 1875) for standard size (3.75m x 21.0m), and pay back period is around 80-100 working days, if it replaces electricity or petro fuels. Cost of drying is reduced by around Rs 800 (US \$ 20) per tonne in solar tunnel dryer compared to the diesel fired mechanical dryer. About 15 units have been installed at users sight and some of the dryers installed are shown in figure below.



Solar tunnel dryer installed at M/s Cotton Products India, Udaipur



Walk in type solar tunnel dryers installed in M/s Raj Surgical, Village Lakkadvas, Udaipur



Solar Tunnel Dryer for drying hand made paper sheets



Rose petal drying in solar tunnel dryer

3.2 Solid State Biogas Plants

It has been designed for anaerobic digestion of cattle dung in solid-state to produce biogas and compost. The fixed dome Janta and Deenbandhu designs modified for digestion of cattle dung in solid-state. The main modifications include feeding through a RCC pipe of 30 cm diameter, enlarge outlet chamber and widened slurry outlet channel. The plant capacity is 2-4 cu m, feed inlet pipe is made of RCC pipe and is 30 cm in diameter. About 25 kg fresh cattle dung/day/ m³ can be feed and the TSC of the feed is kept upto 16% and retention period is 80-115 days

In this plan water requirement is cut by 60 to 100%, handling of the feeding and the digested slurry far easier and space requirement for slurry drying cut by 1/4th compared to the common plant. The average gas yield has been found higher by up to 20% for modified plant as compared to the gas yield for common Janta biogas plant. Degradation of total solids and volatile solids of the cattle dung have also been reported higher by about 40%. The digested slurry discharged from the plant has a TSC of 9.5 – 10.5% and can be transported to fields for use as manure after 2-6 days of drying. The slurry discharged from the common biogas plants has 4-6%TSC and requires drying period of up to 30 days.

The cost of the solid-state plant is almost same as the cost of Janta/Deenbandhu biogas plant of same capacity.



Solid state BGP of 3 m³ at a farmer's at village Periapatti (TN)



Biogas plant in a village near Jorhat (Assam)

Solid state biogas plant in a village



Biogas run kitchen of a progressive farmer

3.3 Biphasic System for Biomethanation of Vegetable Market Waste

The vegetable market waste is normally disposed-off along with other municipal waste. Hence, efforts were made to convert vegetable market waste into methane rich biogas and compost. Acid rich leachate is produced from vegetable market waste (VMW) and used for methane generation. Water requirement is very low. Partially digested VMW is converted into compost in around 60 days. Mechanical materials handling sub-systems are provided in large plants of 2-20 tons VMW /day capacity. Biogas may be used for thermal / mechanical power application. Beside compost, 1.5 - 2.0 m³ / d of biogas (methane content 70%) is produced per 100 kg of VMW handled. It is suitable for all regions where weekly average ambient temperature for winter months is above 15°C. Its approximate cost is Rs 4.5-7.0 lakh/ton/d capacity. The pay back period is **around** three years for 2 ton /day plant. It reduces with increase in capacity of the plant. A full scale system to process 3 ton / d VMW of Sardar Patel Vegetable Market, Anand (Gujarat State) is under operation.



3.4 Solar Refrigerator

The solar refrigerator has been designed to store essential items such as medicine, vaccines etc. at low temperature in standalone mode. It is a small capacity top opening refrigerator powered with SPV panel along with the battery bank, up to 3 days sun autonomy. Temperatures in the range of 10°C down to (-) 7°C can be maintained inside the refrigerator depending upon the thermostat setting. The average power consumption varies between 0.4 to 0.6 kWh / d as compared to 1.0-1.4 kWh / d for the conventional AC refrigerator of 100 litre capacity. It costs Rs. 1,20,000 including SPV panel and DC compressor and is commercially available.

Important Specifications : Refrigerator - Top opening, Capacity 100 litres, Two compartments, Compressor – Danfoss make 12 / 24 V DC SPV panel capacity - 6 x 30 Wp, Battery Bank - Lead acid 130 Ah 24 V, Power Consumption - 60 W, Energy Consumption - 500-600 Wh/day, Inside temperature : 6 to - 7°C, 7 settings



Solar Refrigerator



Solar Refrigerator installed in at a Veterinary Laboratory of CSKHPKVV, palampur

3.5 Natural Convection Solar Water Heater

It can be used for water heating for domestic and industrial applications. Suitable for regions situated in latitude up to 40° . Its salient features are low cost, natural circulation, non – scaling, flat plate type having tube-in-fin absorber. Overnight heat losses from storage tank reduced significantly by using 20 mm thick composite insulation consisting of glass wool and thermocole. It can heats 100 litres of water up to $55 - 60^{\circ}\text{C}$ on a sunny day in winter. Overnight drop in temperature of water is less than 5°C .

Important Specifications :

Solar collectors -- Aperture area : 1m^3 for each collector, Type : Tube - in - fin Absorber, Material : Tube - GI pipe(1.25mm)

Storage tank - 100 litre capacity, Material - GI sheet, Heat Exchanger Plate type



3.6 Multi - Rack Solar Dryer for Domestic Uses

The multi rack solar dryer is a natural convection type device used to dry products like fruits, vegetables, spices etc. for domestic use under hygienic conditions. It has high efficiency, uniform drying of products, option to dry products in shade, suitability for rural/remote places, drying temperature in desirable range, light weight and easy to move.

The maximum stagnation temperature achieved in the dryer in winter months in Northern India was 100°C for solar insolation of 750 W/m^2 and ambient temperature of 30°C . Solar dried Chillies cost 15% lower than the cost of the unbranded product and 57% lower than the branded product available in local market. Pay back period worked out to be 125 drying days

More than 200 units are under use and is commercially available at a cost of around Rs.2500/- .



Multi-rack solar dryer

3.7 Multi-fuel Open Core Down Draft Gasifier

The multi-fuel open core down draft gasifier converts biomass to producer gas for industrial thermal applications. Gasifier system of 60 kg/h fuel burning rate has been thoroughly evaluated. Biomass should have moisture contents of less than 12% and good flow ability. About 60 kg/h wood chips based gasifier system is under regular use for about 16 h/day in a commercial bakery at Udaipur. 6.5 kg of LPG is being replaced by 50 kg of wood every hour of operation. Daily savings in fuel cost is approx. Rs. 2400/- . The 60 kg/h system costs Rs. 3.50 lakhs.

Important Specifications:

Fuels : groundnut shells, wood chips & crop residue briquettes,

Capacity : 0.12-1.0 Mkal/h,

Gas calorific value : 1100 kcal/N m³

Ash removal unit : Manual for small systems & motorized for large systems



Gasifier system installed at M/s Suman Food Products, Udaipur



Gas burner of the gasifier system retrofitted with the existing oven at M/s Suman Food Products, Udaipur

All India Coordinated Research Project on Utilization of Animal Energy

1. **Title of the Project** : All India Coordinated Research Project on Utilization of Animal Energy
2. **Name and Address of the Project Coordinator** : Dr. SK Rautaray
Project Coordinator
AICRP on Utilization of Animal Energy
Central Institute of Agricultural Engineering
Nabi Bagh, Berasia Road
Bhopal – 462023 (M.P.)
Phone : 0755-2734731
Fax : 0755-2734016
Email: skr@ciae.res.in
3. **Research Achievements (New varieties/Technologies Developed/validated and being practiced in the last five years):**

3.1 Development of animal test instrumentation/devices

3.1.1 Portable electronic weighing balance (capacity=1.5 tonne).

It was developed for weighing of animals at sites (In villages) instead of bringing animals to balance at fixed installations. It has 12v battery and inverter system to operate in absence grid electricity. It takes 60 seconds per animal to weigh compared to 130 seconds with mechanical-manual system. The unit costs Rs. 75,000/-.



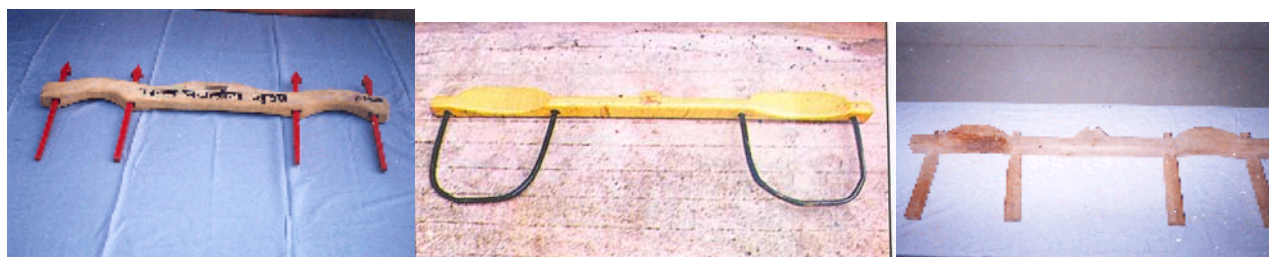
3.1.2 Instrumented treadmill

Instrumented treadmill was developed for measuring physiological haematological, biochemical, skin temperature, cardiovascular and muscle strain responses along with distress symptoms of work animals at different load, speed, slope and duration under varying controlled environment conditions. The system was useful to measure the work and power output of animals in simulated seasonal conditions so as to develop matching equipment for higher output during the limited period of the season.



3.1.3 Improved Yokes and harnesses

Modified yokes were developed using locally available materials for draught animals of different regions as per the breed, size, neck muscles configuration and shape of hump. Due to increased and intimate contact area of yoke on neck muscles the pulling capacity of animal has increased by 10% over the traditional yokes (Draft load = 40 kg) as it has facilitated reduced pressure on neck while pulling load without frequent sliding/rubbing on neck and thus preventing injury to neck in continuous work. The unit price varies from Rs.350/- to Rs.700/-.



3.2 Development of equipment

3.2.1 Animal drawn improved puddler

Different designs of puddlers have been developed suiting to the draft capacity of animals and type of soils for higher quality of puddling at reduced no. of passes (2 passes) compared to the traditional method of puddling by country plough or comb harrow (4-5 passes). Due to rolling action requiring lower draft (50-60 kg) the soil dispersion was higher compared to the traditional practice (Cost of operation Rs/ha=2500/-) at lower cost of operation by 70%. The equipment costs Rs 2000/- - Rs 5000/- depending on the type and size of the puddler.



3.2.2. Animal drawn raised bed planter



Animal drawn raised bed planter was developed for planting vegetable seeds: okra and pea on beds by mounting one two row inclined plate planter on a bund former. The unit costs Rs.3000/-. Compared to flat planted by manual dibbling (Okra yield, kg/ha=800, cost of operation, Rs./ha=1600/-) it saved cost of operation by 60%, increased yield by 10% being the crop on bed and saved irrigation (Rs/ha=300) as the water could be retained in furrows for longer period.

3.2.3 Animal drawn sprouted rice seeder

Animal drawn sprouted rice seeder (8 rows) was developed for row seeding of rice in wet/puddle soil compared to farmer practice of random broadcasting of seeds (@120 kg/ha) which gives high plant mortality, uneven stand establishment and higher cost of weeding. Due to row seeding the savings in Rs/ha for seed=100, saving in labour use for thinning and gap tilling, Rs/ha=300/- and saving in labour use for weeding, Rs/ha =800/- were obtained. The unit price of the seeder is Rs. 4000/-.



3.2.4 Animal drawn inter row crop seeder for rice and sesbania



The equipment was developed for row seeding of rice intercropped with sesbania. For biasi operation the seeding unit was removed and the same frame with two-row biasi plough was operated in row spaces when chopping and mixing of sesbania was done. In traditional practice sesbania seeds are either broadcasted or drilled separately in row spaces as an additional operation. Biasi operation is done thereafter by use of biasi plough. Compared to traditional practice (Rice yield, kg/ha = 2200, cost of operation,

Rs/ha=900/-) the equipment saved Rs 450/- per ha in cost of operation and increased yield by 250 kg/ha. The equipment costs Rs.3500/-.

3.2.5 Animal drawn zero till drill

1,2,3-row seed cum fertilizer zero till drills were developed for direct seeding of wheat under high soil moisture condition after harvest of rice. In traditional practice, farmers normally wait for the soil to be infriable condition after harvest of rice and doing 3-4 tillage operations sow the wheat which often get delayed affecting the yield (Wheat yield, kg/ha=2800, cost of tillage-seeding operation, Rs/ha 3000/-). Use of zero till drill (2-row drill) resulted in 75 % decrease in the cost of operation and increase in yield by 7.5% due to timeliness. The unit price of the 1,2 and 3 row drills are Rs. 2000/-, 3000/- and 4000/-, respectively.



3.2.6 Animal drawn biasi cultivator



Improved biasi cultivator (2 row) was developed for biasi operation in row-seeded rice. In traditional practice, country plough is used in broadcasted rice which is time consuming and results in higher cost of operation, Rs/ha=1350/- and causes high plant mortality giving lower yield (Grain yield, kg/ha = 2500/-). Due to improved biasi operation the grain yield was increased by 7.5% at reduced cost of operation by 50%.

3.2.7 Animal drawn weeder

Animal drawn weeder (Blade hoe/ 3- tined cultivator) was developed for faster weeding in row-seeded crops in limited period of weeding time compared to the manual hand-hoe weeding (Cost of operation, Rs/ha=2000/-). The improved weeder saved Rs.1000/- per ha besides higher command area per season (5 ha). The unit costs Rs.2000/-.



3.2.8 Animal drawn sprayer

Animal drawn sprayer received was modified for effective and faster spraying of plant protection chemicals especially in tall crops. Compared to the conventional method of application by knapsack/foot sprayers (Cost of operation, Rs/ha=300/-) the animal drawn sprayer could save in cost of operation by Rs.100/- per ha besides saving of 0.5 lit/ha of chemicals amounting to Rs.200/-. The sprayer costs Rs.25000/-.



3.2.9 Pneumatic wheel bullock cart

Improved cart was developed for carrying higher load (2 tonne) faster on tar/kuchcha road for longer distance compared to the carrying capacity of 01 tonne by traditional carts. The improved cart was designed optimally by use of standard parts for longer life (10 years) than the traditional carts (Life=3-5 years). The unit price of the improved cart is Rs. 15000/-



3.4 Development of technology

3.4.1 Draftability of bullocks

Draftability of non-descriptive breeds of Assam, Chhatisgarh and Orissa bullocks were measured under different seasonal conditions by use of loading car. The results showed that these bullocks (Average body weight = 500 kg per pair) could negotiate draft equivalent to 10 % of their body weight in all the seasons continuously for 3-4 hours.



3.4.2 Work –rest cycle

Work –rest cycles of 3h (work) – 1h (rest) – 3h (rest) for small bullocks of Orissa, Assam and Chhatisgarh region was found to be appropriate at draft load equivalent to 10% of their body weight. At draft load equivalent to 12% of body weight work-rest cycle of 2h (work) – 1h (rest) – 2h(work) was found to be appropriate for sustained working.



3.4.3 Hardening of hoof shoes

Technology for hardening of hoof shoes was developed. 3000 no. of hardened hoof shes were supplied to the users. Dies for mass production was developed. Results of FLD showed that the life of the hardened hoof shoes was increased by 147% compared to the traditional hoof shoes (Life = 145 h) which in turn reduced the cost of shoeing.



3.4.4 Economical feed formulation for work animals

Economical feed rations based on locally available feed materials were developed for bullock, buffalo, camel and donkey keeping in view the nutrient utilization for increasing the draft capacity. The average expenditure on feed for bullocks (Body weight = 250-350 kg) varied from Rs 40/- to Rs 55/- per day per pair.