



Agricultural Engineering and Technology

FARM IMPLEMENTS AND MACHINERY

Tractor-operated Machinery

Tractor-operated lug wheel puddler: Tractor-operated lug wheel puddler has been developed for high speed shallow puddling of rice fields with higher amount of soil dispersion required for mechanized transplanting of rice. The unit price of the PTO driven rotary puddler is Rs 36,000 and cost of operation Rs 270/ha.

The results of field performance of the lug wheel puddler compared to other puddling equipment tested in single pass showed that with the tractor-operated lug wheel puddler the depth of puddling was maintained shallow (130 mm) with higher amount of soil dispersion (48.6%). The effective field capacity was found



Tractor-operated lug wheel puddler for high speed shallow puddling of rice fields

higher by 21.2–81.8% with higher cost-effectiveness varying from 12.7 to 46% over the other puddlers tested. The unit covers 2.5–3 ha/day and makes the field ready for transplanting in single pass as compared to 3–4 passes of the peg type puddler commonly used by farmers with average coverage of 1 ha/day.

Tractor-mounted inclined plate planter: Six-row tractor-mounted inclined plate planter was modified and adapted for intercrop planting on raised and broad beds.

In laboratory tests, maximum variation in quantity of seeds dropped from different metering units was –4.21 to 4.07% for soybean and –4.86 to 3.84% for pigeonpea seeds. There was no visible mechanical damage to the seeds. Average percentage of cell filling was 99.3 for soybean and 98.9 for pigeonpea. The variation

- Tractor-operated lug wheel puddler developed for high speed shallow puddling of rice fields
- Twin auger digger sugarcane planter to dig two pits simultaneously developed by PAU
- Tractor-operated garlic planter developed and observed seed rate during testing varied from 500 to 700 kg/ha
- A three-row tractor-mounted rotary weeder developed and operated in rows spaced at 1,000 mm in sugarcane ratoon
- Flail type chopper-cum-spreader developed to harvest the straw left after combining and for chopping into pieces for spreading in the field
- High capacity groundnut thresher selected for feasibility testing gave cleaning and threshing efficiency ranged from 96.1 to 99.4% and 97.8 to 99.4%, respectively
- For sowing small seeds like sesame, cumber and sorghum, power-tiller-operated air-assisted seed drill developed

in the quantity of seeds dropped from different seed metering units was within the limit of 5%.

During field trials, three rows of soybean and two rows of pigeonpea at 300 mm row-to-row spacing were sown on broad beds with 1.55 m top width and 1.85 m bed-to-bed spacing. Average depth of sowing was 83 mm. The field capacity of planter was 0.418 ha/h with an effective width of coverage of 1.85 m. Field efficiency was 64.2%.

Sowing of soybean + pigeonpea intercrop on beds with intercrop planter-cum-bed shaper





Furrower: The TNAU, Coimbatore centre has developed a tractor-mounted rotary furrower/trencher. It employs a rotating cutter disc with radial soil cutting blades. The total number of blades were 8 with 45° angular spacing in between. The total effective cutting width offered by the set of blades arranged on both sides of the disc, was 300 mm. The staggered arrangement of blades was provided for uniform cutting action on the soil and to avoid excessive impact loads on the shaft carrying the disc. The replaceable blades were mounted on appropriately positioned frog plates.

A conventional 8.95 kW rotovator gear box was selected for driving the cutting disc. The gear ratio offered by the selected gear box was 1.7 : 1. The driven shaft's end carried a chain and sprocket giving a speed ratio of 2.4 : 1, thus providing 200 rpm rotational speed of the cutter disc at a PTO speed of 540 rpm. An idler wheel was provided to tighten the chain drive accordingly.

Twin auger digger sugarcane planter: PAU, Ludhiana centre in collaboration with M/s Dashmesh Mechanical Works, Amargarh has developed twin auger digger sugarcane planter to dig two pits simultaneously.

The machine consists of a heavy duty frame made of channel sections. Two rotary units are fixed in opposite directions around a heavy duty pipe of 98 mm diameter. A set of three triangular shaped blades made of EN-45 steel are fitted at the end of each helical auger for digging. The distance between the two augers is 1,220 mm. Power from tractor PTO is transmitted to the twin augers through a reduction gear box and belt-pulleys. Cost of the machine is Rs 50,000.

The performance results of the machine gave field capacity from 0.02 to 0.025 ha/h. The effective diameter and depth of pit varied from 700 to 720 mm and from 350 to 400 mm, respectively, in sandy loam soil (moisture content 12.2% d.b). The fuel

consumption and cost of digging were from 6 to 6.5 litres/h and Rs 2.60/pit, respectively. The machine can dig a set of two pits in 40–50 sec depending upon the depth of operation including time loss from one set of pit to the next. Under average conditions it is capable of digging 140–180 pits/h.

Garlic planter: Tractor-operated garlic planter has been developed by MPUAT, Udaipur centre. It is provided with star wheel type seed and fertilizer metering mechanism. The two-row paired hopper and adjustable seed rate are the main features of 12-row unit which has minimum row spacing of 150 mm. The observed



Tractor-mounted garlic planter. The observed seed rate during testing varied from 500 to 700 kg/ha depending on size of garlic cloves

seed rate during testing varied from 500 to 700 kg/ha mainly dependent on size of garlic cloves. The spacing of garlic cloves ranged from 50 to 100 mm. The field capacity, field efficiency and cost of planting were 0.35 ha/h, 70% and Rs 1,300/ha, respectively.

Three-row rotary weeder: A three-row tractor-mounted rotary weeder has been developed at TNAU, Coimbatore centre which

Stationary view of TNAU tractor-operated rotary weeder with rear covers on cutting blade



Twin-auger-digger sugarcane planter in operation





consists of four “L” shaped blades per flange. The length of blade is 129 mm with a blade pitch of 46 mm and bite length of 20 mm. The orientation angle of blade is 50° with the horizontal. The design speed of the rotary unit is 200 rpm.

The test trial of machine was carried out in a total of 16 ha at TNAU, Coimbatore and PAU, Ludhiana centres of AICRP on FIM. For efficient machine operation in sugarcane the row spacing of 3,000 mm is required. At PAU centre of AICRP on FIM, the machine was operated in rows spaced at 1,000 mm in sugarcane ratoon.

Air sleeve boom sprayer: An air sleeve boom sprayer was developed by MPUAT, Udaipur centre. Air sleeve consisted of 4,000 mm length and 260 mm inner diameter with total 44 orifices of 35 mm diameter spaced at 107 mm. As per the laboratory evaluation air velocity of 28 and 32 m/s provided better spray pattern in terms



The air sleeve boom sprayer brings about a major improvement in spraying process by boosting the effectiveness of chemicals and speeding of spraying process thus achieving greater coverage

of droplet size and density, over air velocity of 20 and 24 m/sec. Nozzle angle of 35° and 10° air sleeve angle gave better spray coverage. Droplet size and density varied from 169 to 270 µm and from 11 to 26, respectively.

Flail type chopper-cum-spreader: PAU, Ludhiana centre, in co-operation with a manufacturer has developed a tractor-operated straw chopping machine. It harvests the straw left after combining



Rice-straw chopper-cum-spreader



Modified cutter-bar type rice-straw chopper-cum-spreader

- Flail type mower-cum-chopper developed and commercialized for fodder crop harvesting
- Power tiller-operated groundnut digger developed and tested under prototype feasibility testing in Orissa
- Tractor-mounted rotavator accepted by farmers in many states as a time-saving equipment
- Lowland paddy seeder tested on a large scale in Tamil Nadu, West Bengal and Andhra Pradesh
- Self-propelled high clearance sprayer developed and commercialized
- Self-propelled vertical conveyer reaper accepted for harvesting rice and wheat in Rajasthan, West Bengal and Uttar Pradesh due to high capacity over manual harvesting with sickles
- Portable electronic weighing system for 1.5 tonnes weighing capacity developed for weighing draught animals

and chops it into pieces for spreading in the field in a single operation.

The modified cutter bar type machine has reel speed of 70 rpm and reel diameter of 457 mm. A reel is attached in the front to feed the straw to the cutter. The cut stubbles are conveyed to the chopping cylinder with the help of feeding cylinder attached between the cutter bar and chopping mechanism.

Comparative evaluation of the two rice straw choppers having different types of cutting mechanisms, i.e. flail type and cutter bar type was carried out for paddy straw management. Both the machines were operated in two different straw load conditions of 5.85 and 9.23 tonnes/ha using 37.3 kW tractors. Field capacity of flail type machine varied from 0.35 to 0.38 ha/h at speed of operation of 2.72 km/h. The cutter bar type rice straw chopper-cum-spreader gave field capacity from 0.35 to 0.37 ha/h at speed of operation from 2.65 to 2.69 km/h. After chopping, the straw was incorporated by two passes of disc harrow. Then the field was irrigated and subsequent sowing of wheat was done with no-till drill. The machine is commercially available.

Six-row inclined plate planter: Field trials of CIAE tractor-mounted inclined plate planter were conducted at 5 centres namely JNKVV Jabalpur, AAI Allahabad, MPKV Rahuri, OUAT Bhubaneswar and RAU Pusa centres in total 35 ha.

The seed rate observed for maize in Bihar was 20 kg/ha. The row-to-row spacing was 600 mm. The depth of sowing varied from 30 to 50 mm. At the forward speed of 3.4 km/h, the field capacity and field efficiency were 0.8 ha/h and 75%, respectively. The cost of operation was Rs 274/ha, whereas the cost of manual planting was Rs 480/ha. At OUAT, Bhubaneswar center trials were carried out in 15 ha for groundnut, mustard, maize and greengram in Gajapati, Rayaada Keonjhar, Jajpur and Puri districts. The machine gave field capacity of 0.20 to 0.43 ha/h for different crops in sandy



Inclined plate planter in operation

loam soil. The field efficiency of machine was 62 to 68% for the above said. The working width varied 1,200 to 2,400 mm for different crops. The cost of operation varied from Rs 526 to 1,130/ha. The farmers required spacing from 350 to 400 mm for mechanized sowing operation.

Tractor-drawn ridger seeder/raised bed planter: Tractor-drawn bed planter was demonstrated for sowing cotton crop in 2.4 ha area. The yield was 20% higher over control. There was 35-40% saving in irrigation water. The FLD was carried out at farmer's fields for sowing raya crop covering an area of 26.2 ha. The equipment demonstrated for sowing wheat crop at farmer's fields covered 5.4 ha. The average seed emergence was 189 plants/m² and an average yield was 44.45 q/ha. For sowing of clusterbean, pearl millet and mungbean machine covered total area of 12.2 ha. At farmers' fields there were savings of 25-30% irrigation water, 25% in seeds and 22-25% in fertilizer. The equipment is under large scale popularization. The machine was demonstrated at four centres (TNAU Coimbatore, PAU Ludhiana, JNKVV Jabalpur and GBPUAT Pantnagar) in total 80 ha.

TNAU, Coimbatore centre of AICRP on FIM conducted frontline

Tractor-drawn raised bed planter in working mode



demonstration trials of raised bed planter in total 9.4 ha. The field capacity and field efficiency of machine were 0.278 ha/h and 71%, respectively. The cost of operation was Rs 1,447/ha.

Flail type forage harvester-cum-chopper: PAU, Ludhiana centre has developed and commercialized a flail type mower-cum-chopper for fodder crop harvesting. In a single operation, the machine is capable of harvesting, chopping and loading of fodder crops such as maize, pearl millet, oats in a trailer, attached behind the machine.

Field trials of the machine were conducted at Research Farm, Punjab Agricultural University, Ludhiana for harvesting two major fodder crops. The harvesting of each crop was done after 70 days from the date of sowing. The machine was operated on different forward and flail speeds. The effect of these parameters was observed on the field performance of the machine in terms of average length of chopped fodder, fuel consumption, height of cut, throughput capacity, labour requirement and operational problems encountered.



Forage harvester-cum-chopper. Field trials were conducted for pearl millet and maize

The per cent-weight of chopped fodder up to 80 mm length increased with the increase in the flail speed at all levels of forward speed of the machine for both the fodder crops, i.e. pearl millet.

The throughput capacity of the machine increased with increase in forward speed from 2.16 to 4.40 km/h. The average value of throughput capacity increased from 7.55 to 14.97 tonnes/h for pearl millet fodder crop and 8.09 to 15.97 tonnes/ha for maize fodder crop at flail speed of 36.76 m/s.

Fuel consumption increased with the increase in the flail speed at all levels of forward speed of the machine, for both the fodder crops, i.e. pearl millet and maize. Increase in the flail speed resulted in the reduction of the length of chopped fodder per unit time, thus it involved more energy and increase in the fuel consumption. The overall cost of operation was Rs 1,725/ha at flail speed of 52.75 m/s and forward speed of 2.16 km/h.

Three manufacturers have started its commercial production and a few machines have been sold to farmers.



Rotavator: It is accepted by the farmers of Punjab, Maharashtra, Madhya Pradesh, Uttaranchal, Uttar Pradesh, Andhra Pradesh and Kerala, as a time-saving equipment under lowland and upland conditions. It saved 30–35% of time and 20–25% in the cost of operation as compared to tillage by cultivator. It gave higher quality of work (25–30%) than tillage by cultivator. Soil pulverization with rotavator was found to be better than traditional implements. It could be used effectively for intercultural operation in horticultural crops and for puddling in paddy cultivation. It destroyed weeds, stubbles of paddy, sugarcane, maize and cotton completely. A total of 1,124 ha was covered under frontline demonstrations by 13 centres of AICRP on FIM.

Zero-till-seed drill: It is highly accepted by farmers of Punjab, Uttar Pradesh, Uttaranchal and Bihar after harvest of rice for wheat and vegetable pea crops prevailing in these areas. At 8 centres,



Zero-till seed-cum-fertilizer drill in operation. The machine was demonstrated at Pantnagar (176 ha) and Jabalpur (650 ha) at farmers' field

demonstrations of machine covered 6,691 ha of wheat crop. Sowing is done timely as machine capacity is 4–5 ha/day. Human drudgery is reduced as less number of operations are required. The machine saved Rs 1,000–1,500/ha. The use of machine resulted in 5–6% increase in yield due to early emergence (one week). The machine use was 60–65% cost effective. It saved 60–70% diesel and time of operation. The machine could be used for Bengalgram and pea at NDUAT, Faizabad by replacing furrow openers with those of shovel type.

Eight centres of AICRP on FIM, viz. CIAE, TNAU, PAU, OUAT, CCSHAU, RAU, JNKVV, and GBPUAT conducted field trials in 6,691 ha. The machine was demonstrated at GBPUAT, Pantnagar and Jabalpur in 176 and 650 ha at farmer's fields.

At RAU, Pusa centre of AICRP on FIM the zero-till-drill machine was tested at farmer's field. The field capacity of the machine was found to be 0.65 ha/h and the field efficiency was recorded to be 84%. The seed rate and fertilizer rate were 1,256 kg/ha and 150 kg/

ha, respectively. The average row-to-row distance was measured to be 180 mm. The average number of plants per square meter was 110. The average number of tillers was observed to be 4. It has been found that population of *Phalaris minor* was reduced by 90% and *Chinopodium album* by 75% in the fields sown with zero-till-drill in comparison to conventional sowing. The machine was also demonstrated in Samastipur, Muzaffarpur, Madhubani, East Champaran, West Champaran, Saharsa, Madhepura, Begusarai, Patna, Bhagalpur and Nalanda districts of Bihar. The machine was also used for direct sowing of paddy, mustard, mung, lentil and gram crops. Sowing is done timely as machine capacity is 0.4–0.5 ha/h. Human drudgery is reduced as less number of operations are required. The machine saved Rs 1,000–1,500/ha. The use of machine resulted in 5–6% increase in yield due to faster emergence (one week). The equipment has been commercialized.

Pneumatic planter: The planter saved 16–40% in cost of operation compared to conventional practice by bullock-drawn seed drill. CIAE, Bhopal, TNAU Coimbatore and RAU Pusa conducted demonstrations in a total area of 61 ha.

Semi-automatic potato planter: The machine was demonstrated at NDUAT, Faizabad and CCSHAU, Hisar in 416 ha. Farmers adopted the semi-automatic potato planters due to saving in labour (80%) and cost of seeds (15–20%).

Sugarcane cutter planter: The planter was found to be a time saving equipment over traditional methods. It also saved labour due to combining of many unit operations in a single pass. Sixty-two frontline demonstrations of tractor-mounted sugarcane sett cutter planter were conducted at 5 centres for a total of 226 ha for various sugarcane varieties. The labour requirement and time of operation were reduced by 78% and 50%, respectively. The use of machine gave uniform depth and placement of setts. Planting of sugarcane could be done timely as machine covers about 1.2 ha/day, which also resulted in higher yield.

Strip-till-drill: In Punjab it has been accepted by a few farmers in combine harvested fields. Five centres demonstrated strip-till-drill in 433 ha area. Sowing is done timely as machine capacity is 3–4 ha/day. There was saving in time of 60–62% and in cost of operation by 50–55%. The increase in yield from 2 to 5% was observed at farmers field. The machine reduced human drudgery as less number of operations are required. The machine succeeded in fuel saving of 50–60%. The machine prepared good strip of soil and churned the weeds and stubbles.

Power tiller-operated Machinery

Power tiller-mounted air-assisted seed drill: For sowing small seed like sesame, cumbu and sorghum, TNAU, Coimbatore centre has developed power tiller-operated air-assisted seed drill. The spacing between the rows can be adjusted from 300 mm (for 4



Power tiller-mounted air-assisted seed drill for sowing small seeds like sesame, cumbu and sorghum

rows) to 600 mm (for 2 rows). The machine costing Rs 7,500 covers 2 ha/day. The power to seed metering shaft can be cut off by lifting the tool bar.

The machine was tested at Regional Research Stations, Paiyur, Aruppukkottai and Kovilpatti. Trials were also conducted at farmers field in Veerakeralam. The field capacity of the unit and the fuel consumption were 0.15 to 0.2 ha/h and 0.8 to 1 litre/h, respectively. The cost of sowing of air-assisted seed drill was Rs 250/ha.

Power tiller-operated groundnut digger: A power tiller-operated groundnut digger has been developed by OUAT centre of AICRP on FIM and tested under prototype feasibility testing in different locations in Orissa. The equipment was tested in farmers' fields in village Debil and Bahupadar under sandy loam and clay loam soil at a moisture content of 9.5% and 5.5% (wb), respectively. Effective field capacity and field efficiency varied from 0.05 to 0.07 ha/h and from 72 to 78% respectively.

The harvesting efficiency and cost of operation varied from 97 to 98% and from Rs 1,448 to 2,027/ha, respectively. Effective working width varied from 566 to 575 mm and labour requirement varied from 14.3 to 20 man h/ha. Fuel consumption during test trials was observed from 1.6 to 1.65 litres/h. The power tiller-operated groundnut digger loosened the soil so that groundnut plants with pod could be easily picked up. The machine proved useful under low soil moisture content. The pods remaining in the soil were less than 3%, which could be recovered once the soil was loosened.

Power weeder: The power weeder covered one ha in a day using one operator and two labourers for weeding in between the rows. This equipment was demonstrated in 180 ha area by 5 centres. The farmers observed that use of machine reduced cost of

cultivation, labour and time of operation. The machine performed well when ridges and furrows are less pronounced. The cost of operation was 1/3–1/2 compared to manual weeding. The power weeder worked well in cotton, jasmine, sugarcane, grapes and tapioca crops.

Stationary Machinery

Rice thresher for small farmers: A 0.5 hp single phase electric motor powered thresher for rice has been developed. It is suitable for small farmers, especially farmers of hilly regions. This thresher operates in hold-on mode. It was evaluated for threshing Kranti variety of rice. With a threshing efficiency of 96–98%, the thresher gave an output of 100–150 kg/h. Labour requirement was observed to be 14–20 person-hours/tonne. Initial cost of thresher is estimated to be Rs 8,000 (including Rs 3,000 for motor) and the cost of operation Rs 250–300/tonnes (including labour charges). Weighing only 45 kg (with motor), it can be easily carried by two persons in the hilly terrain.

High capacity groundnut thresher: High capacity spike tooth type axial flow groundnut thresher (PAU design) was selected for feasibility testing. The thresher consisted of threshing cylinder, concave, cleaning system, a blower and a feeding platform. The



Stationary view of groundnut thresher

modifications included change of concave from perforated GI sheet to MS bar type to reduce thrower loss, increase in the opening size/area of cleaning sieve for free flow of pods and provision to check sieve overflow and bifurcation of air flow to both sieves for better cleaning. Cleaning and threshing efficiency ranged from 96.1 to 99.4% and 97.8 to 99.4%. Broken grain loss was almost negligible but breakage of pods was observed at 300 rpm (less than 1%).



Whole crop maize thresher (5.5 kW capacity) in operation

Whole crop maize thresher: The thresher (5.5 kW capacity), was designed with spike tooth cylinder with bolts or flats (6–7/row) fitted in 6 rows on cylinder. Concave was provided with 8 mm square bars at a spacing of 18 mm. Two speed arrangements were provided (720 rpm and 540 rpm) for the threshing cylinder. Two blowers provided better cleaning of grain due to higher straw content. The sieves of 12.5 mm and 4 mm were provided for the removal of trash. Field tests of the thresher gave an output of 3.5–4 q/h and straw size was less than 50 mm.

Straw combine: Demonstrations of straw combine were carried out at CIAE Bhopal, CCSHAU Hisar and GBPUAT Pantnagar in 95, 254 and 105 ha, respectively. Total area covered by the machine

Straw combine in operation at farmer's field



was 454 ha in Madhya Pradesh, Haryana and Uttaranchal.

The test trials of straw combine, at CCSHAU, Hisar centre, gave average field capacity 0.4 ha/h at speed of operation of 2.5 km/h. Average fuel consumption and cost of operation were 4.0 litres/h and Rs 800/ha. Straw recovery was 70.7% with good quality. The straw split was 92.36% and length of *bbusa* was 23 mm. There was an additional grain recovery of 141 kg/ha. The cost of grain recovered is almost equal to the amount paid for hiring the machine. The time required in completing the operation of harvesting and threshing with traditional practice (manual harvesting + threshing with mechanical thresher by manual labour) was about 20 h. Whereas with combine + straw reaper is 3.5 h. During the last two years 3,500 units have been procured by farmers in Haryana.

Sunflower thresher: TNAU Coimbatore centre conducted field trials of sunflower thresher for 112 h at farmers' field. It was introduced by the UAS, Raichur centre in Karnataka. The PFT trials have shown very high acceptance by farmers as there is negligible damage to the seed and very high threshing efficiency (99%). At UAS, Raichur centre, the thresher was demonstrated for 11.5 h. The axial flow sunflower thresher gave 3–4 times higher threshing capacity than conventional thresher. The use of thresher completed the job in shorter time reducing human drudgery. The threshing efficiency was higher (99.5%) and broken grain percentage was very less (<1%). The farmers got sufficient time for subsequent operations for next crop due to timely completion of threshing. It saved 75% labour, time of operation and 30–40% cost of operation as compared to the traditional method.

High capacity multicrop thresher: It was demonstrated at CIAE Bhopal, UAS Raichur, AAI Allahabad and CCSHAU Hisar for a total of 325 h for wheat, sunflower, Bengalgram, sorghum, pigeonpea and soybean. CIAE Bhopal centre demonstrated high capacity multicrop thresher for 160 h. The high capacity thresher was demonstrated among farmers of Allahabad (Uttar Pradesh) and Dharwad (Karnataka) for threshing safflower and redgram. At Dharwad, the thresher gave three times more output than local thresher and it saved 50% labour and time of operation. It reduced human drudgery through saving of time for the same quantum of crop compared to local thresher. The thresher gave clean grain (99%) with negligible grain losses (< 2%).

Paddy thresher (hold on): It is very popular in West Bengal and Tamil Nadu. It was taken up under FLD in Kerala by KAU, Tavanur centre and accepted by the farmers as it saves straw from any breakage. This thresher was found 1.5–2 times more cost effective. About 90% of clean grain could be obtained which further required separate cleaning by employing one man-h/q. For small holdings, it was accepted due to less drudgery and more output



than hand beating. The thresher was highly appreciated due to negligible broken material for fine and medium varieties of paddy in BAU, Ranchi, and it was demonstrated for a total of 180 h.

Manually-operated Machinery

Lowland paddy seeder: It was tested on a large scale in Tamil Nadu, West Bengal and Andhra Pradesh. It was accepted by the farmers as a new technology. Grain yields were higher than transplanted rice and broadcasting method. Line sowing helps in easy interculture and weeding operation. It can be fabricated locally. It was demonstrated by four centres on a total of 121 ha.

Cono weeder: It was used in combination with paddy row seeder in Tamil Nadu and West Bengal. The cono weeder was demonstrated for paddy covering 353.5 ha at seven centres. The implement reduced drudgery due to less time taken (50–55%) compared to hand weeding. The use of the equipment was cost effective by 40–45%. Due to shortage of labour for timeliness of operation, farmers liked the equipment for enhancing productivity. The equipment proved acceptable to women labourers for faster and higher coverage.

Self-propelled Machinery

Self-propelled biasi cultivator: The commercially available light weight power rotary tiller was modified to develop self-propelled biasi cultivator to overcome the problems associated with



Field testing of self-propelled biasi cultivator

the traditional animal-operated biasi tools and to maintain timeliness of biasi operations. The machine is operated by 3.36 kW (4.5 hp) 1,500 rpm light weight diesel engine. Cost of the machine is Rs 50,000. The field performance of self-propelled biasi cultivator in 35 days old dry seeded rice with 150 mm depth of standing water showed that the biasi operation was cost-effective by 15.9 and 47.7% and work rate of self-propelled biasi cultivator was higher by 52.1 and 70.4% over the animal-drawn two bottom biasi

- For planting okra and pea seeds animal-drawn raised bed planter developed
- Commercially available bullock-drawn sprayer modified in respect of orientation of beam and hitch system, operator seat and clutching system for the pump based on the feedback from the field test in soybean
- Wheeled tool carrier developed with attachment of tools for tillage, seeding and interculture
- Technology for hardening of hoof shoes developed
- Economics of animal-based farming system with improved package of implement and practices studied for different cropping system

plough and improved wedge plough, respectively.

Mini combine: The self-propelled mini combine (Model no 4 L 80, Sifang, India) was tested for wheat at CIAE, Bhopal and IIT Kharagpur. The rated power of combine and rated width are 5.15 kW and 800 mm, respectively. It is provided with rubber wheels (size 584 mm × 254 mm) inflated at pressure of 2.11 kpa. For harvesting in paddy fields, these wheels need to be replaced with iron wheels having diameter of 780 mm. The rated engine speed and specific power consumption are 2,600 rpm and 278.8 g/kWh, respectively. The operation can be performed at a speed of 1.6 and 4 km/h in first and second gears.



The field performance of mini combine was assessed for wheat crop at moisture content of 15.4% (db)

The field performance of the mini combine was assessed for the wheat crop at moisture content of 15.4% (db). The combine gave an average field capacity of 0.142 ha/hr and field efficiency of 74%. Fuel consumption and broken grain loss were 1.65 litre/h and 2.1%, respectively.

Rice transplanter (8-row): It was used by the farmers on their own due to scarcity of manual labourers in the areas. Mat type of seedlings helped in growing more number of tillers per



SUCCESS STORY

Custom hiring of improved equipment in Haryana

The farmers and unemployed youth were motivated to use equipments on custom hiring basis as an enterprise. There was wide spread response in its adoption, particularly in areas where paddy-wheat crop rotation is followed. The farmers and unemployed rural youths have already purchased 1,992 rotavators. The enterprising farmers and unemployed rural youth engaged in custom hiring business of rotavators are charging on an average Rs 1,000–1,500/ha for puddling in paddy and Rs 1,500–1,800/ha for sowing of wheat after harvest of paddy. The average area covered by one entrepreneur is about 125–130 ha/year (80 ha in puddling and 50 ha for wheat sowing). The net profit by an individual is about Rs 101,625/year. The pay-back period of rotavator is just one season. The total estimated area covered in Haryana with the use of rotavators in 2004–05 and 2005–06 for puddling was 30,000 and 40,000 ha, respectively. The total estimated area covered to prepare field as reduced tillage technology after harvest of paddy for sowing of wheat in 2004–05 and 2005–06 was 50,000 and 60,000 ha, respectively.

The farmers and young unemployed rural youths have already purchased 8,480 zero till seed-cum-fertilizer drills. Zero-till seed-cum-fertilizer drill covered 4–5 ha/day.

The entrepreneurs/farmers are charging on custom hiring an average Rs 900/ha. Total earning is estimated to be Rs 10,000–12,000/year and the pay-back period of machine is two years. There is about 70–80% saving in fuel. The capacity of machine is 0.4 ha/h. The price of machine is Rs 16,000. The average area covered by an entrepreneur was 50 ha/year. The total area covered by zero-till drill in Haryana was about 5 lakh ha. It saved Rs 2,500–3,000/ha in the cost of wheat production. There are about 25 manufacturers engaged in the production of zero-till seed-cum-fertilizer drill. Zero-till seed-cum-fertilizer drills are being used on large scale in paddy-wheat rotation, particularly to conserve residue of previous crop and to save energy, time and money.

It is estimated that about 50% area under wheat crop is harvested by combine harvester in Haryana with the introduction of straw combine. Farmers were motivated to buy straw combine for self use and on custom hiring for increasing their income. Nine farmers purchased this machine. The area covered by these

farmers was 199 ha (own) and about 570 ha on custom hiring and on an average area covered by a farmer is about 85 ha. The average rate of custom hiring varied from Rs 1,250/ha to Rs 1,325/ha. Average grain recovery was 100–120 kg/ha and *bhusa* recovery was 25q/ha. The cost of machine is Rs 90,000 to 1,20,000 depending upon quality and capacity of machine.

The machine gave a net return of Rs 2,400/ha to the machine owning farmers and about Rs 2,100/ha to one who gets the works done on custom hiring basis. The average field capacity of machine was 0.4 ha/hr while operating at speed of 2.5 km/h. The average fuel consumption was 4 litres/h and two persons are required for its operation. The cost of operation was Rs 800/ha. A farmer can save on an average Rs 66,250–72,625 while the annual expenditure is about Rs 40,000/year. The pay back period of machine is two years only.

The total estimated area covered by straw combine is about 6 lakh ha. The estimated numbers of straw combines in Haryana are about 5,050.

The farmers and rural youth were motivated to buy high capacity multicrop thresher and adopt custom hiring business. About 30 farmers having land from 1 ha to 10 ha were pursued to buy their own thresher and do custom hiring business. All these farmers purchased their own thresher and have adopted it as an enterprise for custom hiring. In *rabi* 2004, area threshed on custom hiring was 137 ha and 327 ha under *raya* and wheat crop, respectively whereas in *rabi* 2005, the area threshed under different crops was 152, 152 and 40 ha (own area) and 431, 780 and 600 ha (custom) under *raya*, wheat and gram crops, respectively. However, the area (1000 ha) threshed by high capacity multicrop threshers in Haryana was about 1,400, 90, 400, 500 and 11 out of total area 2,300, 142, 585, 536 and 13.6 in wheat, chickpea, pearl millet, *raya* and moong crop, respectively.

The farmers and young unemployed rural youths had already purchased about 15,500 high capacity multicrop thresher till 2005–06. The net saving per year is estimated to be Rs 86,000 and the pay-back period is one year. The capacity of machine varies from crop to crop, makes and models. The price varies from is Rs 70,000 to Rs 80,000.

hill. Eight centres conducted demonstrations of self-propelled rice transplanter for different paddy varieties covering a total of 436 ha. The farmers felt that the machine really eliminated human drudgery due to riding facility and very less (1/10) area requirement for raising mat type nursery. The machine saved 80% labour and increased yield by 10–12%. It gave cost effectiveness up to 47% compared to hand transplanting. The machine covered 1–1.2 ha/day and only 4–5 persons were engaged. Training to farmers for mat type nursery raising and machine operation at

each centre resulted in success during large scale demonstration under all types of soils.

High clearance sprayer: It was developed by the PAU, Ludhiana centre and commercialized. UAS Raichur centre introduced it in Karnataka among cotton growers and has been found to perform better as compared to local sprayers. The frontline demonstration of sprayer was conducted in 10 ha area by two centres, organizing demonstrations on cotton without any mechanical damage to the crop even when the crop height was up



SUCCESS STORY

Farm mechanization for tribal region in southern Rajasthan

The equipments demonstrated in Udaipur, Chittorgarh and Banswara districts were tractor-mounted rotavator (42 ha), CIAE multipurpose tool frame (22 ha), power weeder (14 ha), PAU tractor-mounted multicrop planter (40 ha), self-propelled vertical conveyor reaper (65 ha), manual garlic planter (5 ha), CIAE power-operated groundnut thresher (102 h), CIAE high capacity thresher (89 h), multicrop thresher 5 hp Amar make (166 h).

to 1.5 m. During demonstration a good swath (13.5 m) and efficient spraying were observed. It saved 15–20% labour and time and 30% in the cost of operation. It was found that yield increase of 10% was achieved in the demonstration fields.

Vertical conveyor reaper: It is accepted for harvesting of rice and wheat in Rajasthan, West Bengal and Uttar Pradesh by farmers due to high capacity over manual harvesting with sickles. It is commercially available at many places. The self-propelled reaper was demonstrated for rice and wheat for different varieties and soil conditions covering 1,132 ha at 15 centres. It saved 50% labour and cost of operation and 75% operating time. The reaper covered 1.5 ha/day by employing two operators alternately to avoid ill effect due to vibration of handles of the machine.

Animal-drawn Machinery

Animal-drawn raised bed planter: For planting of okra and pea seeds animal-drawn raised bed planter has been developed by mounting 2-row inclined plate planter unit on a bed former. The cost of the unit is about Rs 3,000. The results of field trials have shown an average of 10% increase in yield of okra and peas with savings in irrigation water by 15%. The machine may be more useful in lighter soils for vegetable cultivation.

Bullock-drawn sprayer: The commercially available bullock-drawn sprayer was modified in respect of orientation of beam and hitch system, operator seat and clutching system for the pump based on the feedback from the field test on soybean. The unit having 0.1 m ground clearance was operated at speed ratio (wheel : pump) of 1 : 4 through pulley-belt drive. Six hollow cone nozzles on 5.4 m boom while working at 2.4 km/h speed (112.5 kg draft) gave a discharge of 410 ml/min-nozzle at an average pressure of 344 kPa. The tank capacity is 200 litres for pesticide solution which could be operated for 40 min only at a stretch. The actual work rate was 0.4 ha/h. The unit costs Rs 25,000. The sprayer would be useful for spraying pesticides in soybean, cotton, pigeonpea and other crops.

Tool carrier: Wheeled tool carriers have been developed with attachment of tools for tillage, seeding and interculture. The unit consists of main frame, tool bar and wheel (pneumatic/iron wheels) with provisions for attachment of tools and lifting of tools on turns. The wheeled tools carrier showed advantage in terms of higher command area (1.5–2.5 times) than the conventional implements. The unit with attachments may cost Rs 20,000.

Portable electronic device for weighing draught animals

Portable electronic weighing system for 1.5 tonnes weighing capacity (least count –200 g) has been developed for weighing of draught animals. The system can be operated with 12 V battery and inverter when grid electricity is not available. Average weighing time per animal is 30 s as compared to 129 s for the mechanical-cum-manual system. The labour requirement for weighing of animal is 1.1 person-h/100 animals compared to 7.2 person-h/100 animals with mechanical weighing system. The system can be assembled in 40 min. at the site and found useful for weighing of draught animals in villages.

Improved yokes and harness

Modified yokes have been developed at different centres of the AICRPon UAE to suit the local draught animals as per their size and neck configurations and using local materials.

The modified yokes for bullocks showed an average of 10% increase in pulling capacity resulting into 10–15% increased command area per season. The improved yoke caused no injury to the neck of animals even during prolonged use due to increased contact area of yoke on the neck muscles facilitating reduced pressure on neck and preventing frequent sliding of yoke causing frictional injury on the neck.

Equipment for donkeys in farm operations

Raichur centre of UAE has developed package of equipment for donkey (body weight 160 kg for large white Kathiawad breed) matching their draft capacity (25% of body weight). The package includes iron plough, blade harrow, two-row seed drill, blade hoe, two-wheel steel cart and agro processing gadgets (chaff cutter, caster decorticator and winnower) for operation in rotary mode.

Rotary transmission system for rotary mode application of draught animals

Rotary mode operations of draught animals, especially in off season, would increase the annual utilization by 300–400% compared to the present utilization of about 400–500 h/year. Efforts have been made to develop suitable transmission system for high speed applications. The system consists of a set of bevel gears that converts horizontal rotary motion of draught animal to



SUCCESS STORY

Farm Mechanization Research in NEH Region

NEH, Barapani centre of AICRP on FIM evaluated 4-row manual paddy seeder (15 kg weight). It was pulled by single person which provided field capacity from 0.04 to 0.06 ha/h. The seed rate used between 60 and 80 kg/h in seeder (overall dimensions 1,700 × 940 × 600 mm). The net saving with the use of seeder was Rs 2,000/ha. The labour requirement was 30–40 man-h/ha.

NEH, Barapani centre of AICRP on FIM has developed manual seed drill (13.80 kg weight). The overall dimensions of seed drill are 87 cm × 44 cm × 110 cm. The drive ratio from ground wheel (diameter 40 cm) to metering shaft is 1 : 1. The V-shaped furrow openers; seed hopper (capacity 2 kg) and cup feed type seed metering are salient features of machine. The balanced machine operated by two persons proved boom for farmers for sowing maize and pigeonpea.

NEH, Barapani centre of AICRP on FIM adopted light weight power tiller powered by 3.7 kW diesel engine (Amar make). In valley farmers appreciated its use on narrow terraced lands. The shifting of unit from one terrace to other was easy due to small turning radius and light weight. During field test, the field capacity varied from 0.06 to 0.08 ha/h in tilling. The fuel consumption was from 1 to 1.25 litres/h.

Self-propelled vertical conveyor reaper has been demonstrated on farmers' fields on large scale for rice crop in valley land of the region. Total 5.0 ha was covered during harvesting season of 2004 and 6.0 ha in 2005. The average field capacity of the machine was observed around 0.05 ha/h.

A motorized paddy thresher has been developed and

promoted in the region, which helps in completion of operation in time. In this operation, threshing of paddy crop can be done by holding paddy bundles against moving cylinder and blower helps to throw the broken chaff at some distance away from grain. Thus grain obtained have less chaff and broken straw than pedal type thresher. Overall dimensions of thresher are 850 mm × 750 mm × 750 mm (lxbxh) and total weight excluding prime mover is 50 kg. Two persons are employed to perform threshing operation. One person holds paddy bundle against moving cylinder and second person is required for supplying paddy bundles. Threshing cylinder and prime mover can easily be detached (if necessary) from the frame to enable easy transportation of thresher in hilly area.

Grain output capacity was about 4–5 times more in power thresher as compared to pedal type depending upon crop condition and variety. Labour requirement in per quintal of threshed grain was only one man-h in power thresher and 5 man-h in pedal thresher. Thus there is about 80% saving in labour requirement and cost of threshing grain can be saved up to 74% by using power thresher as compared to pedal type paddy thresher.

For the purpose of winnowing, the farmers of north-east region are mainly dependent on natural wind. The average output of the manual winnower was observed from 2.5 to 3.5 q/h. Due to timeliness of operation, it is gaining much popularity among the farmers of this region. Equipment has been demonstrated for 200 h during last two years.

vertical rotary motion with stepping up speed in the ratio of 1 : 5. The output from the bevel gear has been further stepped up by two sets of spur gears making the combined speed ratio of 1 : 120. A shaft enclosed in a hollow pipe transmits power to the gadgets outside the circular track. The MPUAT, Udaipur centre has provided fly wheel for maintaining uniform rotary speed to the gadgets. A ratchet has also been provided to cut off power when the draught animal stops walking or walks slow. Chaff cutter, paddy thresher, winnower, caster decorticator and few other gadgets are being evaluated at different centres.

Saturation of improved animal-drawn implements in villages and FLDs

Improved equipment packages specific to the prevailing cropping systems in the identified regions were introduced to the farmers in participatory mode. The working of equipment were demonstrated to the farmers through FLDs and feedback was collected for design improvements.

The feedback has revealed that with improved package of

tillage, seeding and inter-culture equipment, 15–25% additional area could be commanded by a pair of draft animals. Using improved package of equipment and practices the farmers have reported 3–5% increase in yield of rice with 18.75% higher cost effectiveness compared to their traditional practices (grain yield 2.9 tonnes/ha and benefit cost ratio 1.44). Similar trend was also reported for other crops. The cost of package of improved tillage/puddling, seeding and interculture equipment for different cropping systems is about Rs 10,000.

Commercialization and mass production of hardened hoof shoe

Technology for hardening of hoof shoes was developed. Pantnagar centre has manufactured 3,000 hardened hoof shoes and supplied to users. Die for mass production of hoof shoe based on the average dimensions of hoof was also developed. Results of FLD showed that the life of the hardened hoof shoes increased by 147% compared to the traditional hoof shoes (life = 145 h) and resulted into savings on the cost of shoeing.



Economics of animal-based farming system

Economics of animal-based farming system with improved package of implement and practices has been studied for different cropping systems. At CIAE Bhopal for bullock-operated rice (direct seeded)—wheat (zero tillage) system the annual productivity was 7.4 tonnes/ha (rice=3.6 tonnes/ha and wheat = 3.8 tonnes/ha) giving overall benefit cost ratio of 2.04 : 1.00. Besides, the specific operational energy and specific cost of production were 1.26 MJ/kg and Rs 2.55/kg of grain produced, respectively.

Horticultural tools

Field trials of horticultural equipment were organised at ten centres namely CIAE Bhopal, TNAU Coimbatore, BAU Ranchi, PAU Ludhiana, KAU Tavanur, MPKV Rahuri, IIT Kharagpur, UAS Raichur, CCSHAU, Hisar and HPKV, Palampur. A total 188 demonstrations of manual and power-operated equipment, namely pruner, chainsaw, grubber, wheel hoe, hedge cutter grafting and budding knives, bill hook, crowbar, fruit harvester, knapsack/rocker arm sprayer, engine powered post hole digger were organised at farmers fields.

TNAU, Coimbatore centre organised a total of 40 demonstrations of horticultural equipment in 16 districts in which 1,427 farmers got familiar with use of these tools and benefited.

PAU, Ludhiana centre organised FLD trials of manual and power-operated horticultural equipment in 16 ha. IIT, Kharagpur centre demonstrated budding knife, lopper, secateur, hedge shearer and wheel hoe for horticultural crops. The capacities of budding knife, secateur and hedge shear were 50–60 grafting/day, 6–7 plants/h and 24 min/hedge, respectively.

KAU, Tavanur centre organised a total of 64 frontline demonstrations of horticultural equipments, namely post hole digger, budding and grafting tools, tree pruners, fruit pluckers, rotavator and mini tillers.

AAI, Allahabad centre demonstrated power chainsaw for cutting tree branches of 310–430 mm diameter at 17 places. The equipment required operational skill to avoid accident. The centre also demonstrated engine powered post hole digger for digging of 445 pits.

BAU, Ranchi centre conducted demonstration of horticultural equipments, namely garden rack, weeding fork, weeding trowel, garden hoe, dutch hoe, pruning secateur, digging fork and hand cultivator. Weeding fork and garden rack gave 3–4 times output capacity as compared to local method. The output capacity of weeding trowel was 6–7 times more than local *khurpi*.

HPKV, Palampur centre demonstrated manually-operated fruit harvester at farmers' field for different fruit crops. The capacity of equipment was 125 fruit/h. The centre also carried out trials of rotavator, ridger, lister, post hole digger etc. under horticultural crops cultivation.

RAU, Pusa centre carried out test trials of manually-operated horticultural equipments namely grass shear, weeding trowel, dutch hoe, hand cultivator, falcon *khurpa* and hand weeder. Farmers appreciated the usefulness of equipments due to high output and lesser fatigue as compared to local hand tools.

CCSHAU, Hisar centre conducted FLD trials on *aonla* picking tool. The manual *aonla* picking tools with 10 nos. of serrations was demonstrated at farmers field which saved costing picking with good quality produce. The centre also demonstrated post hole digger by digging 12,550 pits for planting jatropha, *aonla* and *jamun*, in Shahbad (district Kurukshetra), Agroha, Daulatpur, Baheri, and Dobi (district Hisar).

Ergonomic studies

Ergonomical layout of tractor operator's workplace: The dimensions and location of the important and frequently operated controls of tractor like steering wheel, hand accelerator lever, brake pedals, clutch pedal, gear-shift lever, accelerator pedal etc. have been worked out on the basis of compiled anthropometric data of over 5,000 male Indian agricultural workers and existing work



Ergonomical layout of tractor operator's workplace

place layout of some tractors. Recommendations have been made for optimum length/breadth of accelerator/brake/clutch pedals, steering wheel diameter and its rim thickness.

Tractor seat based on anthropometric data: The seat dimensions of five designs of seats provided on tractors of leading tractor manufacturers in the country were measured using 3-D digitiser in the laboratory. The results indicated that there was wide variation in seat dimensions on different models of tractor seats provided by different manufacturers. However, the different models of the tractors are being used by the same anthropometric population of Indian tractor drivers.

The dimensions for the appropriate design of seat of a tractor were optimized based on compiled anthropometric data of 5,434



male agricultural workers and ergonomic evaluation of five commercial tractor seats. The recommendations of the study are being passed on to leading tractor manufacturers for modification of seats on existing tractors through consultancy projects.

Belt and chain conveyer feeding system for high capacity thresher: A belt and chain conveyer feeding system was developed by PAU centre of AICRP on ESA in collaboration with an industry. The thresher with this type of feeding mechanism was tested for threshing of wheat crop from 16 ha, i.e. about 70 tonnes of crop. The thresher was operated by a 55 hp tractor. The throughput capacity of the thresher was 3.3 tonnes/h and the output capacity (grain) was 1.5 tonnes/h. Not only the labour requirement was reduced, the drudgery involved in feeding of crop to the thresher was also reduced as the crop was to be lifted to waist height only as against 180 to 240 cm (above shoulder height) in case of traditional high capacity threshers.

Safety gadgets for sugarcane crusher: A power-operated sugarcane crusher is one of the accident-prone equipment. TNAU centre, Coimbatore has developed safety gadgets to make the operation safer for workers. The gadgets include feed plate/feed chute, guard for power transmission system, tool for applying grease to transmission system and a hand hook for begasse removal. These devices were demonstrated to the farmers.

AGRICULTURAL ENERGY AND POWER

Renewable Energy Technologies

Solar tunnel dryers: CIAE Bhopal and SPRERI V V Nagar centres have developed low tunnel solar dryers of different geometries. The dryers consist of two sections—one works as solar air heating section and other as drying section. Solar photovoltaic unit-operated mini DC fans have been used for circulation of air and removal of humidity from the drying unit. The solar dryers have been evaluated for drying various fruits, vegetables and fish. The inlet air temperature increased by 20°–30°C in the dryer. Clean, unprocessed Bombay duck fish having moisture content of up to 85%, got dried in 10–11 clear sunshine hours in the dryer. Drying time for unripe mango pieces, gooseberries and chilli, in general, reduced by 50% in the dryer as compared to open sun drying. Besides, quality in respect of microbial count, ascorbic acid and acidity of the product obtained from the dryer was significantly superior to the open sun-dried product.

High rate anaerobic treatment system for dairy effluent: Based on the technology developed at SPRERI centre of the AICRP on RES, a pilot plant for anaerobic treatment of dairy effluent has been designed, installed and commissioned at Vidya Dairy of Anand Agricultural University, Anand. The plant consists of a collection chamber, an anaerobic filter and gas storage unit, biogas-based

SUCCESS STORY

Anti-cancer properties of soybean and soy-isoflavones

An *in vivo* study was conducted to explore the anti-cancer activity of soybean and its isoflavones on B16-F10 melanoma tumour in mice with special reference to tumour growth inhibitory, therapeutic and preventive effects. Among various treatments, the maximum regression in terms of the volume doubling time (VDT) and growth delay (GD) was observed in case of the therapeutic treatment with daily intake of FFSF or isoflavones @ 1 g or 0.88 mg, respectively/kg body weight of mice, given orally. For both the parameters the effects were highly significant ($P < 0.0001$) as compared to control. The response of silent period and VDT of preventive effect was also highly significant ($P < 0.0001$) while the GD was significant ($P = 0.030$) as compared to the control.

The mean survival time (MST) of 39.25 days and 41.5 days for FFSF and isoflavones treatment respectively, against 30.76 days for control, in growth inhibitory effect were also highly significant. In case of therapeutic treatment, the MST were 28.6, 40.0 and 44.9 days for control, FFSF and isoflavones, respectively. The preventive treatment of soyflour and isoflavones were observed to be most effective in increasing MST (41.5 and 46.6 days as against 29.2 for control group). The results indicate that the treatment of FFSF and isoflavones, in both the treatments exhibited highly significant increase in the MST ($P < 0.0001$).

Oral administration of FFSF and isoflavones observed to produce 33.33 and 41.37% increase in life-span in the growth inhibitory experiments. The respective percentage increases in life span were 28.79 and 42.42% for therapeutic and 38.33 and 55.33% for preventive treatments for FFSF and isoflavones. It has thus been concluded from the study that daily intake of recommended levels of appropriately processed soybean (60–65 g) or isoflavones (1 mg/kg body weight) has highly significant effect in retarding or preventing cancer and also increasing mean survival time and life-span of cancer patients. No curative effects have however, been observed.

power generating system and necessary pumps, piping and accessories to treat 12,000 l/d of effluent having organic load of 15,000 mg COD/l. The treatment plant including power generating set costs about Rs 6.5 lakh. The plant is producing 95 m³/d of biogas having 80% methane content and the residual COD of the effluent is reduced to only 1% of the COD of the influent in the reactor.

Family size floating dome type biogas plant for solid-state digestion of cattle dung: The MPUAT Udaipur centre of AICRP on RES modified 2 m³ capacity floating dome KVIC biogas plant for solid-state digestion of cattle dung. The inlet of the plant has been replaced with RCC/OVC pipe of 30 cm internal diameter,



SUCCESS STORY

Entrepreneur established soy-based food products enterprise with technical help of CIAE Bhopal

SPU Centre of CIAE, Bhopal has developed process technologies for 24 soy products and 18 equipment and regularly organizes entrepreneurship development training programmes for transfer of process technologies to upcoming entrepreneur. About 866 participants from different states attended the same and 160 entrepreneurs established their own cottage scale soy processing enterprises at different regions of the country. Mr Eknath Dhamdhare is one of them who is successfully running his soy-based food products enterprise under the banner of Sangram Soy Food Products at Mundhawa, Pune, Maharashtra.

laid at a minimum angle of 75° with horizontal and the upper end of the pipe kept approximately 1 m above the ground level for easy feeding of dung under gravity. An agitator has been provided inside the gasholder for breaking the scum. Provision has also been made for locking the gasholder. Initially the plant is charged with well-prepared 1 : 1 mixture of cattle dung and water and 10% digested slurry collected from a plant under operation. When the plant gets stabilized the substrate is changed to fresh cattle dung.

Biogas plant 2, 3 and 4 m³ capacity have been installed at more than 50 selected users' sites during the last 2 years in Punjab, Haryana, Rajasthan, Madhya Pradesh, Maharashtra, Assam, Gujarat, Karnataka and Tamil Nadu. Compared to the common designs, these plants cost up to 10% more, but require 75–100% less water for operation, produce up to 30% more gas, require ¼th space for slurry drying, and feeding/handling of digested slurry is far more easier.

Technology for enrichment of biogas digested slurry:

UAS Dharwad centre carried out operational research demonstrations of the technology at 5 selected farmers' fields. All the farmers owned 2 m³ or bigger biogas plants and used lignite based PSB D1 culture @ 100 g for every 100 litres of digested slurry along with rock phosphate for enrichment. The incubation period was 30 days. The enriched biogas slurry was used by the farmers for growing onion, groundnut and potato crops in *kharif* 2005 season. It was found that the crop yield in plots treated with P-enriched biogas slurry was almost at par with the plots given recommended dose of mineral fertilizers.

Anaerobic digestion of crop residues: The SPRERI centre of AICRP on RES studied anaerobic digestion behaviour of rice straw and sugarcane trash at 25% and 35% total solid concentrations and 35°C reactor temperature. The C : N ratio was

adjusted by adding oilcake and FeCl₃ was used as process enhancer. It was found that the substrate at 25% TS and supplemented with FeCl₃ and organic nitrogen resulted into substantially higher gas yield (210 litres/kg TS for sugarcane trash and 280 litres/kg T for paddy straw) in 35 days of incubation period. Subsequent bench scale trials were encouraging. The gas production was in the range of 370–430 litres/kg TS.

Biogas burner for community applications: CSKHPKV Palampur centre of AICRP on RES has developed blower type biogas burner for community applications. It consists of an electric motor, gas nozzle, gas mixing column and conical flat type burner. The cost of these burners has been found to be Rs 2,000–2,500. The burner efficiency of 70% has been recorded as compared to 42% for the conventional ring type burner of 1.1 m³/h gas burning capacity. The blower type burner is under regular use in veterinary hostel of the University at Palampur.

Technology for biodiesel (ethyl ester) production:

GBPUA&T Pantnagar centre of AICRP on RES carried out studies on esterification of raw Jatropha oil with ethanol using KOH as catalyst. Various levels of aqueous ethanol, catalyst concentrations and reaction temperatures were investigated using 6 : 1 molar ratio for oil and alcohol, reaction time of 90 min and settling time 24 h. The results of the study indicated that the Jatropha oil at 6 : 1 molar ratio may be treated with 170° proof ethanol at 70–75°C reaction temperature for 90 min in presence of 3% KOH and the allowed to settle for 24 h to get maximum ester recovery with lowest possible kinematic viscosity. The result of 12 h continuous rating test of 3.73 kW engine at a constant speed (1,500 rpm) using methyl and ethyl esters and diesel fuel indicated that the fuel consumption and emissions of HC and CO were lower for ethyl ester of Jatropha oil as compared to methyl ester.

Industrial scale solar drying of fruits and vegetables:

SPRERI Vallabh Vidyanagar centre installed a forced flow solar drying system on a farm near Ahmedabad for drying 125 kg of tomatoes per batch. The PAU design, packed bed type, solar air heater used in this system is 30–40% more efficient than conventional solar air heaters. The drying system was provided with LPG back-up for supplementing the heat for operation during cloudy weather/non-sunshine hours. The total investment in the system has been about Rs 4.1 lakh and the cost of dried tomatoes has been estimated to be Rs 50/kg. Comparative evaluation of the system was carried out for drying chilli using LPG alone and solar drying without LPG. The moisture content of chilli was reduced from 94 to 16% in 9 h of operation at 80°C using LPG fuel. When the system was operated only on solar energy, the moisture content of chilli was reduced from 94 to 14% in 12 sunshine hours.

Jute caddies briquettes as an alternative fuel: Attempts were made to produce briquettes from the caddies in a ram type



mechanical press coupled with a hammer mill grinder having capacity of 125 kg/h. The calorific value of jute caddies briquettes having 1,068 kg/m³ density was estimated to be 3,923 kcal/kg. The briquettes could also be gasified to generate producer gas successfully in a gasifier plant of 10 kW capacity. Briquettes of jute caddies as well as jute stick can be suitably exploited to generate thermal energy as the process heat in industry. Moreover, the low ash content of caddies makes it an appropriate feed material in gasifier reactors. Thus, gasification of briquettes may provide a new avenue for cogeneration of heat and power to meet industrial need by waste recycling and management.

POST HARVEST TECHNOLOGY

Optimization of process parameters for hulling of pigeonpea

Hulling efficiency and hulling losses were optimized for pigeonpea. Effects of hulling time, moisture content and cottonseed and mustard oil as pre-milling agents were studied and optimized using response surface methodology. The maximum hulling efficiency of 89.59% was obtainable at 9.84% moisture content (wb), 11.96 second time of hulling and 0.28% cottonseed oil treatment. The hulling efficiency was 83.19% at 10.11% moisture content (wb) and 12.3 second time of hulling with 0.30% mustard oil treatment after optimization. Linear model developed for hulling loss showed significant effect of time of hulling, whereas effect of oil treatment and moisture content were non significant.

Cleaner-cum-grader for light seeds

A cleaner-cum-grader for light seeds like berseem, cumin and coriander has been developed at CIAE, Bhopal. The unit separates the seed based on their pneumatic/aerodynamic characteristics by air classification method. The capacity of the equipment for

Cleaner-cum-grader for light seeds



- Effect of hulling time, moisture content and cottonseed and mustard oil as pre-milling agents studied and optimized
- Cleaner-cum-grader for light seeds like berseem, cumin and coriander developed
- Broken sunflower kernels used to prepare three confectionery products
- A process technology for scientific production of anardana developed
- A mobile cool chamber designed with a conventional cycle rickshaw for short distance transportation of fish

separation of berseem is 300 kg/h, whereas it is 130 kg/h for cumin and 180 kg/h for coriander seeds. The power requirement is in the range of 250–300 W.

Curry leaf stripper

A curry leaf stripper has been developed at the CIAE- Regional Centre, Coimbatore. The capacity of the machine is 40-50 kg/h



Curry leaf stripper in operation

with stripping efficiency of 90–95%. The cost of the unit is approximately Rs 15,000 and saving in labour over the conventional method is about 80%.

Determination of the maturity of intact mango on tree

A model to predict maturity index based on correlation of colour with TSS has been defined to measure the maturity of mango objectively. The model can be used on farm with the colorimeter by orchard owners. Alternatively, colour and maturity index charts have also been developed to use it with any colorimeter. If colorimeter is not available, one can get digital photograph of the mango and can know the maturity or sweetness in terms of TSS using a commercial software using this technique. This technique



can be employed to sort the mango based on either maturity index or TSS (sweetness) at export port, big *mandies* and in processing plant. It will also help in fixation of price of individual mango based on total soluble solids.

Process technology for making *aonla* beverage

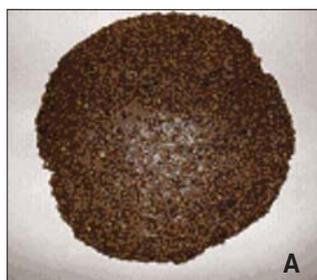
A process technology was developed to prepare *aonla* beverage in the form of juice with attractive colour, appealing flavour and smell. The composition of *aonla* juice (20%), sugar syrup (70% –25° B), other fruit juices (guava, pineapple etc.) (10%) were found best in terms of acceptability.



Black salt, white salt, black pepper, *amchur* powder and dhania were the other ingredients used for making the beverage. The final mixture is bottled and sterilized in hot water before storage.

Development of sunflower kernel-based confectionery products

Broken sunflower kernels were used for preparation of three confectionery products. The broken kernels were cleaned manually to remove any adhered hull or damaged kernels. Cleaned broken kernels were graded to have uniform size with appropriate set of sieves to improve the appearance of sunflower kernel-based confectionery products. Sunflower kernel caramel snack, a sugar based sweet containing sunflower kernels, was prepared using different sugar and kernel levels. Sunflower-sesame kernel confection *chikki* is an improved traditional product and prepared taking jaggery, sunflower kernel and sesame kernel in different proportions. Likewise, sunflower kernel ready-to-eat sweetmeat was



A. Sunflower kernel caramel snack food; B. Sunflower-sesame kernel confection *chikki*; C. Sunflower kernel ready-to-eat sweetmeat

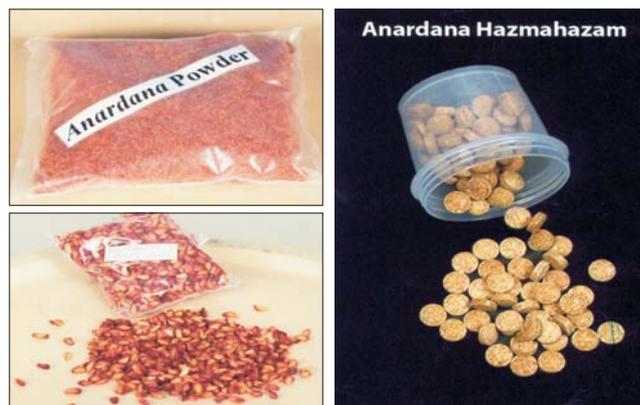
prepared incorporating sugar, jaggery, sunflower kernels, liquid glucose and honey.

Rotary maize cob sheller

The sheller is simple and safe with an output capacity of 65 kg/h and costs only Rs 1,500. It has been found suitable for all varieties of maize with zero damage during shelling, and thus better suited for seed purposes.

Process technologies for value-added products from pomegranate

A process technology for scientific production of anardana has been developed at CIPHET. The product contains desirable acid sugar ratio and retains maximum quality parameters (sugars, TSS, vitamin C and minerals) up to six months of storage. Process for pomegranate jelly has been developed. The jelly is good in



The value-added products from anardana contain desirable acid sugar ratio and retain maximum quality parameters

appearance, colour, nutritionally rich in vitamin A and minerals, has good keeping quality with natural flavour. It can be stored for 4 months under ambient conditions and 6 months in cold storage. Mouth refreshing, nutritive and digestive tablets from anardana have been prepared. The product has acceptable taste and flavour, is rich in nutrition, minerals and digestive in nature. It can be stored up to six months when packed.

Technology for soy-millet biscuits

Efforts have been made to develop soy-based *kodo* and *kutki* millet biscuits. Various levels of flours 70, 80, 90 and 100% of both *kodo* and *kutki* (black and white varieties) were tried for substitution of refined wheat flour in the standard formula of soy-fortified biscuits.

Based on the physical and textural properties and sensory evaluation, substitution of refined wheat flour with *kodo* flour up to 70% level and addition of 10% skimmed milk powder produced



Soya-kodo biscuits

acceptable soy-*kodo* biscuits. In case of *kutki* refined wheat flour substituted at 80% level with 10% skimmed milk powder produced biscuit of acceptable quality. The process and composition have been standardized and is ready for adoption at commercial level.

Guava leather/bar

A process technology for production of guava leather/bar has been developed. The product was prepared by mixing various blends of different fruit pulps. Guava, mango, papaya, sugar, citric acid and permissible preservatives are the main ingredients. Drying



was carried out in a cross flow cabinet dryer. The dried sheet was then cut into definite shaped fruit bars. This guava leather/bar can be stored for 2–3 months under normal condition and more than nine months under cool dry condition.

Fish container mounted on cycle rickshaw

A mobile cool chamber has been designed with a conventional cycle rickshaw for short distance transportation of fish. An insulated chamber made of GI (inner) sheet having length 1,250 mm,



Mobile cool chamber with a conventional cycle rickshaw for short distance transportation of fish

breadth 760 mm, and 750 mm height with a single door opening at back was mounted on the cycle rickshaw. The chamber was provided with 40 mm thick insulation of thermocol all around. A 300 mm × 300 mm opening was kept at the top of chamber for retail marketing the fish. A backside door is provided for loading the ice-fish filled crates inside the chamber. The total capacity of this chamber is 150 kg of fish with 80% filling of each plastic crates and 1 : 1 ratio of ice and fish. This could store the freshwater fish for 5–6 days.

Performance of poly house solar dryer for chillies

Bapatla (ANGRAU) centre has tested a poly house solar dryer of size 7.5 m × 4 m × 3 m to dry about 10 quintals of ripe chillies. The dryer consists of an arch type poly house to hold chillies in two tiers. The drying time is 5–8 days to reduce moisture from 75% to 10% (wb) in comparison with 15–20 days required to dry chillies in traditional open yard sun drying. The added advantages are high retention of colour and quality. Such dryers are being promoted by the Government of Andhra Pradesh.

Processing and preservation of drumsticks

Drumstick (*Moringa oleifera*) pieces processed and preserved at Coimbatore (TNAU) centre by curing process (10% saline alone and in combination with 1% acetic acid) and by canning process (in 1, 2, 3% saline and tomato pulp from local and hybrid variety tomatoes) were found to be good without any fungal attack after one year of storage.

Cryofreezer

A freezer of 10 kg capacity has been designed, fabricated and tested at IIT, Kharagpur in an ICAR Project. It uses liquid nitrogen (LN₂) as coolant. Use of two chambers, one for precooling the food materials by exit nitrogen gas and other chamber for freezing by LN₂ improved



the thermal efficiency of the system by more than 25%. This has also reduced the LN₂ consumption considerably. Reversal of the LN₂ flow after achieving the required freezing has permitted to overcome the problems of food handling (loading and unloading) from pre-cooler to freezer and vice versa. Shrimps, tomatoes and potatoes of different sizes were used to evaluate the freezing characteristics.

Hand-operated aonla pricking machine

HAU Hisar centre of AICRP on PHT has developed a hand-operated aonla pricking machine. The capacity of the machine has been estimated to be about 15 to 20 kg/h and the approximate cost of the machine is Rs 2,000.



Seed pelletizer

A power-operated seed pelleting machine was designed and developed at Anand Agricultural University, Anand (Gujarat) for safe and efficient pelletization of seeds, particularly the small and irregular seeds. All the desired constituents such as fertilizer, micronutrient, growth hormones, seed protection agents, etc. can be incorporated into the pelletized seeds. The capacity of the machine is 1.5–2 kg/h depending on the seed characteristics. Pelletizing efficiency was greater than 90% in all cases with 85–95% of these pellets containing only single seed. The size of the seed pellets could be increased to about 4–5 times the original size of the seed, with sphericity ranging from 0.82 to 0.91. Field experiments for different types of stored pellets showed high germination percentage and plant height. The cost of the machine is about Rs 31,000. The estimated cost of seed pelletization is about Rs 28/kg of seed.



Production of a protease and a biosurfactant by a *Bacillus* sp. and their potential applications as bread improvers

Use of protease as an additive or improver of quality and to retard the rate of crumb forming will limit the use of chemical additives as antistaling agents for baked products. In this study,

microbial strains of *Bacillus* sp. were isolated and screened for concomitant production of protease and biosurfactant under an ICAR funded project at University of Delhi, New Delhi. One of the strains selected for higher production was identified, using 16 Sr DNA sequencing, to be *Bacillus licheniformis* RG1. Among the various carbon and nitrogen sources studied as the substrate medium, soyflour and corn starch were found to be the best for protease production.

The protease produced was successfully applied in a bakery (M/s Tushar Food Industries, Delhi) for preparing bread loaves with better softness and longer shelf-life (up to 5 days) compared to control loaves.

HCl-gas based cotton seed delinting plant

A cottonseed delinting plant of one tonne per hour capacity has been designed, developed and tested successfully by Maharashtra State Seeds Corporation Limited (MSSCL), Akola under an ICAR funded project and found commercially viable. The process developed makes use of hydrochloric gas for cotton seed delinting to replace employing wet sulphuric acid, which involves environmentally unsafe effluent. Demonstrations and trainings of pollution-free cottonseed delinting were organized at cotton delinting plant, Shivani (Akola) in collaboration with Directorate of Cotton Development (Government of India), Mumbai. Maharashtra Pollution Control Board has certified that this technology is pollution free.

FIBRE TECHNOLOGY

Design and development of an improved cotton saw gin

Despite their higher productivity, saw gins available in India provide inferior quality lint with loss in length, particularly while processing long and extra long staple cottons. The high speed of saw results in fibre breakage and lower ginning percentage. A lot of fuzz also remains with the seed thereby affecting the quality of

Improved cotton saw gin

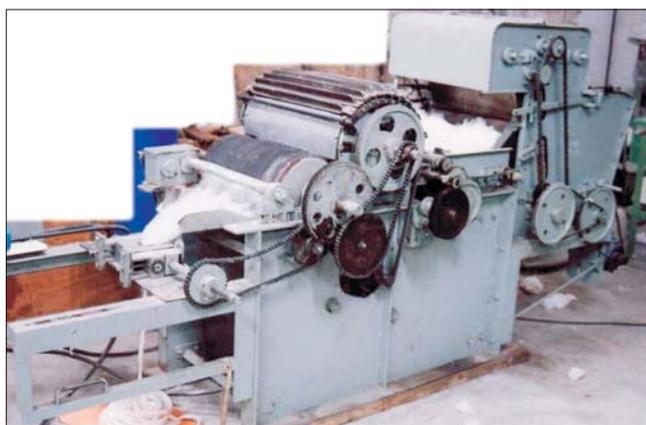




output. The currently available saw gins do not have provision to optimise the output based on the staple grade. To overcome the above deficiencies, a prototype of an improved 45 saw ginning machine has been designed and fabricated. This model has, apart from a provision for regulating feeding rate, necessary controls for saw speeds to be optimized depending on the staple grade.

Low cost cotton sliver making machine (CIRCOT Mini Card)

A low cost sliver making machine, named as CIRCOT Mini Card, has been developed for sliver production from cotton with 1.8 kg/h production. The machine consists of two detachable units (a) pre-opener and (b) carding including sliver making unit. It is suitable for application at village level and can be used in conjunction with traditional roving and yarn making machines



CIRCOT Mini Card, the low cost sliver making machine

for production of good quality yarn. Recent field trials have indicated that the quality of yarn from the sliver produced on this carding machine by conventional method followed in the village was quite satisfactory.

Extraction of banana pseudostem fibre

Use of only outermost 5–6 layers of banana pseudostem for fibre extraction has been in practice. Studies have indicated that up to 10 layers could be effectively used for the fibre extraction. This has resulted in substantial increase in fibre yield. The fibre thus collected is lustrous, clean and free from other extraneous matter. The fibre yield was higher in machine extraction than hand extraction, but the quality was better in hand extracted fibres than machine extracted fibres. The chlorinated lime as a bleaching agent at 0.75% produced better quality lustrous fibre irrespective of the banana varieties. Thus machine extraction coupled with bleaching of fibres chlorinated at 0.75% produced maximum yield and better quality fibres.

A machine known as Banana Pseudostem Fibre Cleaner has been developed that removes non-fibrous material and gives silvery white and lustrous appearance to the fibres.

Pilot plant for particle boards from cotton plant stalks

A one tonne per day (1 TPD) automatic particle board plant using indigenous machinery has been installed at the Ginning Training Centre of CIRCOT, Nagpur, to demonstrate the feasibility of cotton stalks as raw material for particle board manufacture.



Pilot plant to manufacture particle boards from cotton plant stalks

This plant has been put into operation and 1.2 m × 0.9 m three-layered particle boards are being manufactured. By making available cotton stalks for particle board industry, a farmer can earn Rs 500/tonne.

Value-added textile from sunhemp fibres

Raw sunhemp fibres could be processed using jute spinning system. When subjected to chemical treatments (such as scouring, bleaching and softening as used for jute), the fibres retained enough strength for its subsequent use in spinning and weaving. There was a substantial improvement in whiteness and brightness of the bleached fibres which would facilitate dyeing in several colours to produce bright shades. Union fabric has been produced weaving sunhemp yarn in the weft and cotton in the warp direction by optimizing the weaving parameters (especially the picks per inch at 20). The thick fabric has been effectively used for making baggage, upholstery items, etc. and possibly for jeans and jackets.

Flush door shutter using jute stick particles and jute felt

Low-cost flush door having dimensional stability in extremities of climatic conditions has been developed for both household as



SUCCESS STORY

Empowerment of Women

- Bhopal sub-centre of National Research Centre for Women in Agriculture (NRCWA) conducted a survey to assess the involvement of women in agriculture and found that women devote 43.7% of their time in agriculture.
- Ergonomical evaluation of manually-operated two-row drum seeder, TNAU four-row drum seeder and CRRRI four row rice transplanter was carried out with women workers. It was found that the physiological load in terms of heart rate and pulse rate was higher than the acceptable limits of 110 and 40 beats/min, respectively. The working heart rate and pulse rate for operation of CIAE sickle, KKV Dapoli sickle, improved sickle and local sickles were within the acceptable limit.
- Training of woman workers on woman-friendly tools and implements were conducted at Village Chawani Pathar, Adampur and Nepania Jhat, attended by 52 and 103 women workers, respectively. The training was imparted on fertilizer broadcaster, 2-wheel seed drill, one-wheel seed drill, twin-wheel weeder, groundnut decorticator, hanging type grain cleaner, naven dibbler, seed treating drum and furrow and bund makers.
- During September 2005 – October 2006, the SPU centre of CIAE organized seven training programme for 115 rural women from nearby Bhopal district of Madhya Pradesh on various aspects of soybean processing and production soy milk, soy paneer, bakery items and soy snacks for use of soy foods in daily diet for nutrition and health benefits. Awareness camps and demonstrations were also held at different places like Seoni, Guna, Shajapur and Baramati.

well as industrial applications. This substitute of conventional veneer board is made using composites prepared from 10 mm thick non-woven jute felt. Jute felt is impregnated with water soluble phenol-formaldehyde resin which imparts the water repellent property. The physical and mechanical properties of the boards; swelling character, impact strength, internal bond strength and modulus of rupture; were found comparable to those of wooden veneer board. Nearly 80% wood used in conventional flush door shutter can be replaced by the use of jute veneer boards.

Warm fabric (shawl) using bulked yarn made from jute polyester blends

Jute and hollow polyester fibres can successfully be blended in the ratio of 70 : 30 in the conventional jute spinning system to produce bulked yarn suitable for making warm fabric. Shawl fabric can be woven using the blended yarn as weft and commercial cotton yarn of about 6 tex as warp in handloom weaving machine with jacquard attachment. Plain and twill designs were developed.

Body and border of the shawl were decorated by specialized jacquard weaves. The shawls, though heavier than the commercially available woolen shawls by about 12%, give 62% more warmth as evident from the thermal insulation values.

Fancy jute fabric using jute-based cover yarn

The major problem associated with jute yarn is its hairiness and fibre shedding. The protruded hairs, besides affecting adversely the weaving system, impart a cloudy appearance to the fabric. Furthermore, the extensibility of jute yarn is poor restricting its diversification. The problem has been overcome by developing cover yarn in the existing jute spinning system using jute polyester blended core and synthetic fibres such as polyester, lycra and metallic filament as covering material. About 90–95% hairiness is reduced, work of rupture is increased by about 40% and there is an overall improvement in flexural rigidity and packing co-efficient. Percentage of jute in this fabric can be maintained in the range of 75–98%. Several utility products such as school bag, office bag, soft luggage have been developed out of the fabric made from cover yarn. Knitted products such as bottle-carry bag, ladies bag/purse with better aesthetic appeal and physico-mechanical properties are the other potential uses.

Trainings

Short Course on Drainage Technologies

A training programme on Drainage Technologies for enhancing agricultural productivity in vertisols was organized during August 2–11, 2006 for 27 participants at CIAE, Bhopal.

Advanced Instrumentation

A six-day training programme on Advanced Instrumentation for R&D in Agricultural Engineering was organised at CIAE, Bhopal for faculty members of the SAU's during August 21–26, 2006.

Agro-based Products

CIAE organized entrepreneurship development training programme on agro-based products for 29 participants of District Poverty Initiative Programme (DPIP) during June 12–17, 2006 and July 10–17, 2006.

Manufacturing Technology

A 11-day training programme on Manufacturing Technology for Fabrication of Agricultural Implements for Teachers/Instructors of Farm Machinery Vocational Education was organized in collaboration with PSSCIVE, Bhopal at CIAE, Bhopal during September 18–28, 2006. Eighteen instructors from different vocational training institutes from Punjab, Haryana and Madhya Pradesh participated in the programme.



LAC TECHNOLOGY

Lac marketing in India

The study revealed that the Palas tree is the most important lac cultivating host tree in all the selected states when compared to Ber and Kusum. Net returns from lac cultivation was much higher in Maharashtra (Rs 214,848) in comparison to Chhattisgarh (Rs 12,117). The low extent of host tree exploitation was the prime factor for low lac production. Constraints adversely affecting lac production at the farmers' level were lack of funds (own) and non-availability of cheap credit for purchase of inputs including brood lac. Cultivators received better price in those markets where purchaser sold scrap lac directly to processing units.

Small scale lac processing unit

Indian Lac Research Institute, Ranchi has developed a set of four machines required for setting up small scale lac processing unit, viz. scraper-cum-crusher, washer, winnower and grader. These machines can be driven manually or by electric motors. If such unit is established by setting up manually-driven machines then total cost of machinery will be approximately Rs 40,000. The area where electricity supply is available, then such units can have power driven machinery which will cost approximately Rs 60,000. The capacity of such small lac processing units will be 100 kg/day. If a processing unit remains functional for six months in a year, about 750 man-day/year employment can be generated. Net profit of about Rs 30,000/month can be earned. Total cost for establishment of such unit including civil works will be about Rs 500,000.

Pilot-plant of lac dye

A pilot-plant has been designed and developed at the Institute for production of technical grade lac dye from wash water of sticklac. The plant can produce up to 2 kg (max.) of technical grade lac dye from washing of 400 kg of sticklac. The different

A new host of kusmi strain of Indian lac insect

Prosopis juliflora, a native of South and Central America, has recently been identified as a quick growing potential host of kusmi strain of lac insect. It was introduced in India to combat desertification but has spread in different states and often considered as a weed. The potentiality trials conducted on this host in Gujarat have shown an overall yield ratio of 1 : 21 (brood lac input : output) of aghani (*kusmi*) crop during winter season. Due to its abundance (in millions) with less economic significance, its identity as a good lac host is expected to help not only for boosting kusmi quality lac production in the country, but also for socio-economic development of the rural mass in these disadvantaged areas. It is a quick growing species having a good coppicing response and can reach lac inoculable stage after 2-3 years of planting. A large scale trial of aghani crop is in progress on 300 plants, in three locations of Bhavnagar and Kuchh districts of Gujarat.



wetted parts of the plant like tanks, pipes, valves, pumps and filtration unit are made of synthetic material (HDPE, HDPP, PVC) and stainless steel to avoid the contaminations in the final product (pure/food grade lac dye).

The technical grade lac dye is further purified for making it pure/food grade. The lac processing industries are presently disposing of the wash water as effluent, can recover this byproduct, as pure lac dye, which can, further enhance economy of the lac processing units. The pure/food grade lac dye has present market price of Rs 5,000–6,000/kg (approx.).