

TECHNOLOGIES DEVELOPED DURING 2014-15

I. CENTRAL INSTITUTE OF AGRICULTURAL ENGINEERING, BHOPAL

I.1 Rotary Assisted broad bed former-cum-seeder

The rotary assisted raised bed former-cum-seeder is useful for seeding of soybean and wheat crops on raised beds. Provision has been made for attachment of rotavator in order to form fresh bed or perform sowing operation with reshaping of bed by using bed shaper only. This machine makes the bed of top width of 1200mm and height 200 mm. The field capacity of this machine for making fresh bed and sowing is 0.35 ha/h and for reshaping of bed and sowing is 0.56 ha/h. This machine consumes 15 l/ha fuel for bed making and sowing at speed 3 km/h. Weight of the machine, with and without rotavator is 550 and 150 kg, respectively. Rolling type bed shaping system as power wheel is a special feature of this seeder. Due to rolling action of bed shaper attached in this machine, bigger size clods do not get exposed and a smooth bed is formed. The cost of the machine is Rs. 1,30,000/- (approx.).



I.2 Self-propelled multipurpose hydraulic system for orchard management

The self-propelled multipurpose hydraulic system is useful for harvesting of fruits like mango, sapota and citrus. It has a hydraulically powered self-propelled platform type elevator operated by 8.2 kW (11 hp) petrol engine. It employs a full hydraulic drive system with 360° steering, which effectively solves the steering problem typically encountered in the narrow spaces in orchard fields. It can navigate smoothly through an undulated terrain. It is stable on slopes less than 8° and has good climbing ability. It has a low center of gravity while still maintaining good ground clearance. Lifting, lowering of the platform; forward, backward movement and steering of the machine are controlled by the operator from the platform. The hydraulic system of the machine ensures that the machine will not be able to move if the engine stalls on steep slopes. The open center hydraulic system enables the machine easy to operate and requires low maintenance and hence low cost as compared to other design. Attachments for cutting, pruning, spraying etc. are developed which is powered by the machine hydraulic system. The cost of machine is Rs. 6,50,000/- (approx.). The technology has been commercialized by licensing to Ms Tafe, Chennai.



I.3 Multi Millet Thresher

Multi-millet thresher has been developed for threshing and dehulling of different types of millets. The capacity for threshing and dehulling



are 100 and 50 kg/h, respectively. The power requirement of the machine is 1.5 kW (2 hp), single phase electric motor. The overall dimensions of the machine (length, width and height) are 1300 × 1300 × 1100 mm. The weight of the machine is 150 kg and unit cost is Rs 45,000(approx.).

I.4 Biomass based decentralized power generation plant

The value chain for biomass based decentralized power generation plant is very useful to generate the electricity by using the crop residues of soybean, pigeon pea stalk, cotton stalk, which are burnt in the field. It has added value to biomass from Rs 400/tonne to Rs 1200 per tonne for power generation. Cost of power generation from biomass is Rs 6-7 per kWh. The system has a 100kW capacity with 500kg/h capacity of biomass briquetting. The investment for this plant is around Rs 100 lakhs (approx.).



I.5 Process technology for soy-butter

Soy-butter is healthy, nutritionally rich; cholesterol and trans- fat free plant based spread with high protein content of 39 % making it ideal for people who are suffering from protein malnutrition, obesity and hypercholesterolemia. It has no added flavour and preservatives with a shelf life of 3 months under ambient conditions. It can be used as a spread in sandwiches, parathas, rotis, bland crackers or cookies. It can be a component of ‘Mid-day meal’, *Anganwadis* or other health promoting schemes as a low cost high protein food especially for children. It is also aimed at providing entrepreneurship opportunities to soybean farmers for value addition of their produce. Commercially it can be used as a flavour constituent and binder in bakeries and confectionaries or as filler in chocolates and bakery products. The initial investment in the technology process is around Rs 8 lakhs for plant of 250kg/day capacity with a cost of production as Rs 190 per kg (approx.). The expected price is around Rs 300-400 per kg of soy-butter. A patent for the technology has been filed and also has been commercialized through licensing with Ms Bionutrients India, Bhopal; Sanavegan products, Vishakapatnam; Lovesoy foods, Mysuru.



I.6 CIAE millet mill

CIAE Millet mill is designed for dehusking minor millets viz., foxtail millet, little millet, kodo millet, proso millet and barnyard millet. It works on a principle of gentle abrasion/attrition and cyclone separation.



This machine has a capacity of dehusking 100 kg/h at 10-12% (wb) moisture content and operates with 1 hp single phase electric motor. The separation of the husk is simultaneous with a suction arrangement and cyclone separator attached to the machine. The dehusking efficiency of the machine is about 95%. The husk is gently trapped and collected from the hulled kernel in single step with minimum power. The total weight of this machine is about 112 kg (excluding motor). The cost of the equipment is Rs 60,000 (approx.). The technology has been commercialized through licensing with M/S AVM Engineering Industries, M/s Perfura Technologies India (Pvt.) Ltd and M/s Valampuri Industries, Tamil Nadu.

I.7 Continuous feed aloe vera whole gel extraction equipment

Continuous feed aloe vera whole gel extraction equipment extracts aloin free aloe vera whole gel from aloe vera harvested at an optimum stage. The equipment consists of top and bottom pair of rubber pressure rollers assembly fitted with high carbon steel blades below the upper roller and above the lower roller driven by power source (either motor or by manual rotation) through a gear transmission mechanism. Set of stainless steel rods are provided at the outlet of the gel, which separates the top rind layer of the leaves and the gel. The whole gel is directly collected in the food grade tray which is partially filled with clean water. The top and the bottom rinds are collected separately. The capacity of the equipment is about 200 - 225 kg/h (900 - 1000 leaves/h) when motorized and 100 kg/h (400 - 450 leaves/h) when operated manually. The saving in time and cost over conventional method is up to 70% and 50%, respectively. The aloin content in the extracted whole gel is within the acceptable limits. The cost of the equipment is Rs 60,000/- (approx.). The patent has been filed and equipment has been commercialised.



I.8 Post-harvest mechanization package for banana central core

A package of equipment for the minimal processing of banana central core consists of slicer, dicer, fibre remover, surface water remover, juicer /grinder and juice squeezer. The details of the equipment are summarized.

- a) Slicing Unit: The slicing equipment is motorized (1 hp, single phase) which takes the central core to the cutting blade automatically, by the cam arrangement .A rotating cutter blade fixed inside a casing slices the core. The primary fibre accumulated during the slicing process is easily removed. The cost of the machine is Rs. 50000/- (approx.) with a capacity of 35 - 40 kg/h.



- b) Dicing Unit: The sliced pieces are diced (7.25 x 7.25 x 9 mm) into small cubes which are directly collected and soaked in a trough having pre-treated water with standardized preservative to arrest the browning reaction, for 30 min. The dicing is carried out by continuous rotary dicing unit and a nylon circular roller, using dicing blades. The equipment is operated by 1 hp single phase motor. The cost of the machine is Rs. 55000/- (approx.) with a capacity of 40 kg/h.



- c) Fibre removing unit: After dicing of banana central core, the secondary fibre is removed in the fibre removing unit. A spindle is fixed to the shaft of a 0.5 hp single phase motor for removing the fibre, which rotates at 200 rpm for 5-7 min. The central core fibres are wound around the spindle



arms. The initial cost of the machine is Rs. 15000/- (approx.) with a capacity of 10 kg/batch.

- d) Surface water removing unit: The surface water in the diced banana central core is removed using two concentric cylindrical stainless steel drums, to increase the shelf life and also for arresting further browning action. The inner drum has 3 mm diameter perforations around the surface and rotates at a speed of 1440/720 rpm by 0.5 hp single phase motor. The outer stationary drum has an outlet to remove the excess water. The cost of the machine is Rs. 25000/- (approx.) with a capacity of 7 kg/batch.



- e) Juicer Grinder: For extraction of juice, the central core has to be reduced to fine size before the juice is squeezed out from it. This is performed by high speed juicer/ grinder (2800 rpm) with 2 hp single phase/three phase motor. The juicer/grinder is tiltable and made up of stainless steel with a set of six blades fixed to the rotating drive shaft and a tight lid on the top. The cost of the machine is Rs. 30000/- (approx.) with a capacity of 4 kg/batch and 40-45 kg/h.



- f) Juice Squeezer: The ground paste of juice is fed into juice squeezer for extraction of juice which is hygienic, without direct contact of human hands reducing contamination. The cost of the machine is Rs. 15000/- (approx.) with a capacity of 2 kg/batch or 40-45 kg/h.



By using this package of equipment, one can save time and cost up to 65% and labor by 75% for minimal processing/ juice extraction of banana central core. The banana central core, which is wasted, can be converted into value added nutritious products for human consumption, thus helping in generating additional revenue to banana farmers / entrepreneurs / processors.

II. AICRP ON FARM IMPLEMENTS AND MACHINERY (FIM)

II.1 Tractor operated small seed planter

The six row tractor operated small seed planter unit is suitable for sowing small seeds (onion) at 150 mm row spacing and adjustable plant to plant spacing. The cost of the unit is Rs. 60,000/- (approx.) with a field capacity and cost of operation being 0.16 ha/h and Rs. 5090/ha, respectively. There is a saving of 50% in cost of operation and 81% in labour requirement as compared to traditional method.



II.2 Tractor operated fertilizer dibbler for ratoon sugarcane

The field after harvest of sugarcane is covered by a mat of trash to a depth of 150 mm and hence punch application enables placement of fertilizer through crop residue. The tractor operated fertilizer dibbler is suitable for ratoon sugarcane for placement of fertilizer without much soil disturbance and through crop residue. The main components of the implement are revolving spade, fertilizer metering device, fertilizer placement funnel, soil covering and pressing device. The cost of the unit is Rs. 45,000/- (approx.) with a field capacity of 0.2 ha/h. The cost of operation is Rs. 1550/ha with a saving in cost of 60% as compared to the conventional method.



II.3 Drift control shield for a hydraulic boom sprayer

Drift control shields are made of fiber sheet (3 mm thickness), the first being a single circular shield with radius of curvature of 0.3 m and the angle of inclusion of 90° and the second a circular shield with radius of curvature of 0.4 m and angle of inclusion of 75° . The second shield is directly mounted above the first shield. Hydraulic boom sprayer without shield was operated at a constant pressure of 680 kPa at tractor forward speed of 2.5 km/h. The average drift at 5 m distance increases from 5.6 to 6.8 mg without any shield with increase in wind velocity from 1.5 to 2.0 m/s. Similarly, the average drift at 5 m distance increases from 3.86 to 3.94 mg with single shield and from 1.6 to 2.8 mg with double shield with increase in wind velocity from 1.5 to 2.0 m/s. The average drift at 10 m distance increases from 5.8 to 6.6 mg without any shield with increase in wind velocity from 1.5 to 2.0 m/s. Similarly, the average drift at 10 m distance reduces from 4.00 to 3.86 mg with single shield and increases from 1.7 to 1.9 mg with double shield with increase in wind velocity from 1.5 to 2.0 m/s. It is concluded that shielding of spray boom reduces spray drift in hydraulic boom sprayers by 35-42% with single foil shield and by 68-73% with the use of double foil shield.



II.4 Tractor drawn planter cum boom sprayer

A planter with four nozzles herbicide spraying attachment is suitable for groundnut crop with an herbicide application rate of 494 l/ha at HTP sprayer pressure of 200 kPa. Weed population is 62% less with herbicide application as compared to without herbicide application. The field capacity of the machine is 0.62 ha/h at forward speed of 2.5 km/h. The planter cum herbicide sprayer can perform sowing and spraying of herbicide operations in groundnut crop simultaneously.



II.5 Power operated onion de-topper cum grader

Power operated onion de-topper cum grader is suitable for de-topping and grading of onion crop. It is operated by two single phase 0.75 kW electric motors with a detopping capacity and de-topping efficiency of 238 kg/h and 86%, respectively. The unit cost and cost of operation of the machine are Rs 85000/- (approx.) and Rs 256/t, respectively. It saves time, labour and cost of operation as compared to manual method of onion de-topping and grading.



III. AICRP ON ERGONOMICS AND SAFETY IN AGRICULTURE (ESA)

III.1 Pedal operated maize dehusker sheller

The pedal operated maize dehusker sheller has been developed for dehusking and shelling of maize cobs keeping anthropometric and ergonomical parameter of workers into consideration. The machine is operated by two people, one for pedalling and another for feeding unhusked cobs. The capacity of the machine is 130 kg/h, while the grain damage is less than 1%. The dehusking and shelling efficiencies of the dehusker sheller are 97% and 95%, respectively. The workers can change their jobs after 30 minutes and thus the machine can be operated continuously throughout the day with normal rest pauses. The cost of the equipment is Rs. 28,000/- (approx.) which is affordable for small and medium farmers as well as for farmers in tribal areas.



III.2 Safe two wheel tractor trailer

A safe two wheel tipping trailer (5 tonne capacity) with safety features having a hydraulic braking system, a rear overturning protection mechanism, a side (lateral) overturning alarm indicator, and the lighting and other safety features has been developed which costs Rs 2.5 lakhs (approx.).



III.3 Hand operated coconut dehusker

The coconut dehusking operation is generally performed with a scythe or a sharpened knife (shovel) fixed over a wooden log in a bending posture with high chances of injuries. In order to minimize drudgery, a hand operated coconut dehusker has been developed which gives output of 212 dehusked nuts/h, against traditional dehusking method (99 nuts/h) and implement factory dehusker (97 nuts/h). The dehusker weighs 5.5 kg and the cost is Rs. 800/- (approx.). More than 100 units of this dehusker have been purchased by farmers and are in use.



III.4 Improved ladder for apple harvesting in Himachal Pradesh

A light weight improved ladder has been developed for harvesting apples in hilly region. The ladder has been made from locally available bamboos and weighs 12.5 kg. Its height is 240 cm. This bamboo ladder helps the women workers to carry out the plucking of fruits comfortably, and can assist one worker to harvest about 100 kg of apples/h. It can also be used for plucking other fruits like apricot, walnut, pomegranate and for other household chores.



IV. AICRP ON UTILIZATION OF ANIMAL ENERGY (UAE)

IV.1 Bullock drawn engine operated sprayer

The bullock drawn engine operated high clearance sprayer for cotton and pigeon pea crop consists of a modified frame of a commercial bullock drawn sprayer and a power sprayer operated by a 3 hp engine mounted on the frame. The salient feature of sprayer is high ground clearance of 920 mm and wheel of larger diameter (1230 mm) for further enhancing higher ground clearance. The bullock drawn engine operated sprayer made of mild steel has a field capacity of 1.2 ha/h, weighs 305kg with a dimension of 3900 x 1240 x 2120 mm and costing Rs 90,000/- per unit (approx.).



IV.2 Animal drawn zero till Drill for hilly region

A two row zero-till seed drill for sowing wheat under zero tillage after harvest of paddy consists of an inverted T-type furrow opener. The field capacity and field efficiency of zero till drill is 0.03 ha/h and 79 % respectively at operating speed of 1.8 km/h. The equipment made of mild steel, weighs around 27 kg with the cost of operation of seed drill being Rs 2409 per hectare.



IV.3 Bullock drawn ridge type 8-row paddy drum seeder

Bullock drawn 8-row drum seeder for sowing of paddy on wet land has an average row to row spacing of 19 cm with a seed rate of 30.0 kg/ha and a field capacity of 0.2ha/h. The seeder is made of mild steel, weighing 54kg with dimensions of 1760 x 1260 x 740 mm. The field efficiency of drum seeder is 68 %, with the cost of seeding of Rs 118 per hectare. The cost of one unit of 8-row paddy drum seeder is Rs 13,500/- (approx.)



TECHNOLOGIES DEVELOPED DURING 2015-16

I. CENTRAL INSTITUTE OF AGRICULTURAL ENGINEERING, BHOPAL

I.1 Pre-emergence herbicide strip applicator-cum-planter

A 6-row strip applicator unit has been developed as an attachment to inclined plate planter for pre-emergence herbicide application at the time of sowing in widely spaced crops such as soybean, pigeon pea, maize, cotton etc. It helps to control weeds along the crop rows, often not possible through mechanical weeding. The machine consists of a frame on which 6 flat fan spray nozzles are mounted by means of clamps; a single action piston pump with 9 l/min capacity; pressure regulator valve; pressure gauge and pressure pipes. The spacing between the spray nozzles, angle and height of spray nozzles can be varied by adjusting the clamps. The machine can save about 40-70% herbicide in comparison to blanket application. The initial cost of the applicator with inclined plate planter is Rs. 66,800/- (approx.). The operating cost has been worked out as Rs 1350/ha. The same machine can be used as post-emergence herbicide/pesticide applicator after the removal of furrow openers and increasing the height of nozzles from the ground.



I.2 Seed-cum-ferti drill with two stage fertilizer placement system

A tractor drawn five-row seed-cum-ferti drill has been developed to apply the fertilizer at two stages (at seed depth and 50 mm below the seed) in single pass for wheat and soybean. Overall dimensions of the machine are 2070 x 1445 x 1340 mm. The weight and working width of the machine are 200 kg and 1500 mm, respectively. Field capacity of the machine is 0.53 ha/h at forward speed of 3.5 km/h. The cost of the machine is Rs. 45000/- (approx.) with a cost of operation being Rs. 600/h. The maximum yield can be achieved by applying the fertilizer at 40 mm side and 50 mm deep from the seed. This machine has potential to increase the wheat yield up to 15% and soybean yield up to 22% as compared to traditional practices with same fertilizer dose.



I.3 Multi millet seed-cum-fertilizer planter

The multi millet seed-cum-fertilizer planter for planting of small seeds (eg. kodo, little millet, proso millet, foxtail millet, barnyard millet, finger millet, mustard, jute) consists of vertical rotor type metering device of different slot sizes as per seed and fertilizer rate requirements; seed-cum-fertilizer box; a ground wheel of 400 mm diameter, shoe type furrow opener and seed delivery tube. Traditional method of seeding by broadcasting requires about 30-40 kg/ha seeds of minor millets. For line sowing by traditional method the required seed rate is 10-12 kg/ha. By using this machine, seeds can be saved to the tune of 90% as compared to broadcasting and 70% as compared to drilling by traditional methods and gives higher productivity. It will be useful for small and marginal farmers of tribal areas to promote production and productivity of millets as a whole.

a. Manually operated single row multi millet seed-cum-fertilizer planter

The field capacity and field efficiency of the developed machine is 0.05-0.06 ha/h and 62-70%, respectively when the machine is operated at forward speed of 1-2 km/h. The overall dimensions, weight and draft of the machine are 1170 x 450 x 1100 mm, 20 kg, 100-200 N, respectively. The cost of the machine and operating cost are Rs. 5000/- and Rs. 600-700/h, respectively.

b. Bullock drawn three-row multi millet seed-cum-fertilizer planter

A bullock drawn three-row multi millet seed-cum-fertilizer planter has a field capacity and field efficiency of 0.12-0.14 ha/h and 65-70%, respectively when the machine is operated at the forward speed of 2-3 km/h. The overall dimensions, weight and draft of the machine are 700 x 1000 x 900 mm, 35 kg, 400-500 N, respectively. The cost of the machine and operating cost are Rs. 25000/- and Rs. 800-900/h, respectively.

c. Tractor drawn six row multi millet seed-cum-fertilizer planter

The tractor drawn six row multi millet seed-cum-fertilizer planter has a field capacity and field efficiency of 0.52-0.62 ha/h and 70-82%, respectively when the machine is operated at the forward speed of 3-4 km/h. The overall dimensions, weight and draft are 700 x 2100 x 1000 mm; 75 kg and 800-900 N, respectively. The cost of the machine and operating costs are Rs. 35000/- and Rs. 1000-1200/h, respectively.



I.4 Process technology for CIAE Nutribar

CIAE Nutribar is prepared with nutritionally and functionally rich base mix containing flaked oats, puffed rice, germinated and flaked green gram and soybean; malted finger millet, milk powder, roasted peanuts crushed and papaya. Jaggery has been used as a binding and sweetening agent. The nutri-bar is rich in protein (10g/40g), iron (6mg/40g) and anti-oxidants. It has no added flavour and preservatives with a shelf life 2 months in a three layer pack in vacuum under ambient conditions. It can be used as a 'on the go', easy to carry snack for instant energy and protein. It can be a component of 'Mid-day meal', *Anganwadis* or other health promoting schemes as a low cost high protein food especially for children. It is also aimed at providing entrepreneurship opportunities for value addition of farmers produce. The initial investment in the technology process is Rs 10 lakhs (approx.) for plant of 1000 bar/day capacity with an estimated cost of production as Rs 14 per bar (25 g each) and sale price as Rs 20 per nutribar.



I.5 Solar PV based refrigeration system for storage of horticultural produce

The solar PV powered refrigeration system for storage of horticultural crops has the capacity to prolong the shelf-life of horticultural produce (mango, tomato, capsicum, marigold flower etc.) by 2-4 weeks. The cold storage room of 5000 x 4400 x 3000, m has a solar PV array capacity of 25kW_p, power conditioning unit capacity of 25 kVA, 3 phase and a battery bank capacity of 900AV, 240 V. The vapour compression refrigeration system is 2.5 TR with a 6-7 tonne cold storage capacity. The operating cost of the cold storage system is reduced by 40-50% by use of the solar energy. The cost of the entire unit is Rs 20-25 lakh (approx.) and the profit can be enhanced by storing produce during glut market situation and selling at demand.



I.6 Mechanization package for bud chip propagation in sugarcane

The complete mechanization package for sugarcane bud chip and planting has been developed. The package consists of equipment for removal or scooping of bud chip, portray filling for sugarcane bud chips, protocol for Storage and transportation of sugarcane bud chips, equipment for fungicidal treatment for sugarcane bud chips and mechanized planting of sugarcane bud chip settlings grown in portrays. The details of equipment and protocols is given below:

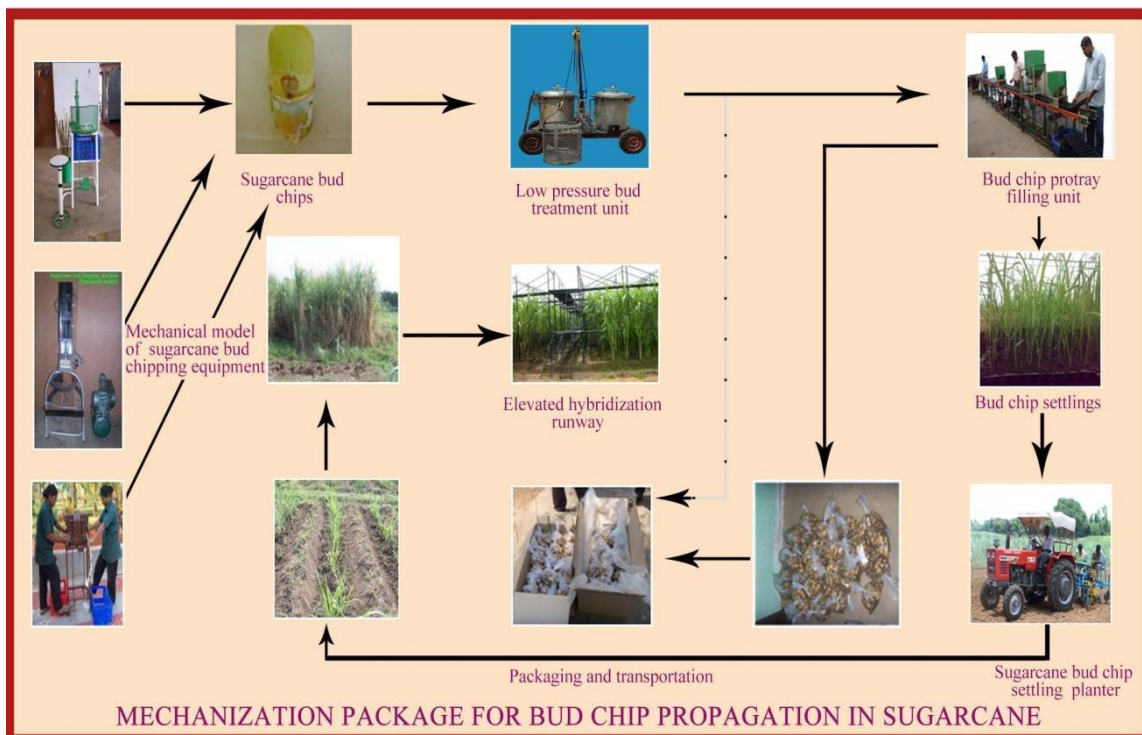
- a. **Removal or scooping of bud chip from sugarcane:** Three models of sugarcane bud chipping equipment have been developed
 - i) Pedal operated sugarcane bud chipping machine: The capacity of the equipment is about 550 bud chips/hour. The cost of the equipment is Rs 5,000/- (approx.). Saving in cost of operation and time is about 26 and 80%, respectively.
 - ii) Pneumatic powered sugarcane bud chipping equipment: The capacity of the equipment is about 1100 bud chips/ hour and cost is Rs 35,000/- (approx.) including the cost of 1hp compressor. Saving in cost of operation and time is about 50 and 88%, respectively
 - iii) Motorized model: The capacity of the equipment is about 2500 chips/hour. The cost of the equipment is Rs 30,000/- (approx.). Saving in cost of operation and time is in the tune of 60 and 90%, respectively.

- b. **Equipment for portray filling for sugarcane bud chips:** The capacity of the equipment is 150 portrays/hour. It fills the portray cells with soil media, places the bud over it, covers it with soil and sprinkles water over it as the portrays are moved on a conveyer. The cost of the equipment is Rs 1,25,000 (approx).

- c. **Protocol for Storage and transportation of sugarcane bud chips:** Transportation of sugarcane bud chips in corrugated boxes (7ply; 160 flutes/m (A type); liner thickness 0.20 mm and median thickness 0.325 mm),with sugarcane trash and air bubble sheet as cushioning material, showed significant effect on retaining the germination of sugarcane bud chips over 12-15 days.

- d. **Fungicidal treatment for sugarcane bud chips:** A mechanised system for low pressure plant protection chemical treatment of sugarcane buds/setts has been developed to address the issue of red rot and smut disease management in the sugarcane setts / buds before planting. The equipment under low pressure of about 400 mm Hg reduces the quantity of chemicals being treated per hectare, soaking time by almost 90% and achieves more effective penetration of the chemical in to the sugarcane sett s/buds. Since the same chemical can be reused, the saving in chemical used for pre-treatment was 80 - 85%, thus making the system environment friendly, addressing the issue of optimized chemical use in agriculture. The equipment caters to about 20,000 sugarcane bud chips 2000 double set buds and can be hitched to the tractor and transported to the sugarcane field, making it very convenient to use. The cost of the equipment with accessories for transporting, loading and unloading of the setts/buds is Rs 3.5 lakhs (approx).

- e. **Mechanized Planting of sugarcane bud chip settlings grown in protrays:** A tractor operated two row planter for sugarcane bud settlings where the settlings from the nursery can be dropped by two operators through the indexing tray rotated by metering mechanism for planting in rows at a predetermined row to row spacing. Furrow openers open the furrow, in which the settlings with soil are to be planted. The same furrow is used for irrigation after the settlings have been planted. The furrow closer which follows the soil opener closes the soil thereby giving stability to the settling plants. The row to row spacing (900, 1200 and 1500 mm), plant to plant spacing (450, 600 and 900 mm) and depth of the planting can be adjusted. The field capacity of the equipment is 0.20 ha/h and the missing percentage of 3 to 4 at a working speed of 1.4 km/h at a row spacing of 1.2 m and field efficiency of 70 per cent. The plant establishment is around 95%. The yield and quality parameters are on par when compared with manual planting. The cost of the equipment is Rs 1,00,000/- (approx.).



I.7 Mechanization package for rope making from outer sheath of banana pseudostem

The package of equipment consists of equipment for splitting the outer sheath of banana pseudostem and equipment for twisting and winding of splitted strands from outer sheath of banana pseudostem

a) Equipment for splitting the outer sheath of banana pseudostem

The equipment contains a pair of rotating nylon rollers with HSS circular cutting blades embedded on the first roller. The second roller has the grooves on the surface of the rollers such that the blades embedded on the first roller exactly fit into the grooves of the second roller. The first roller is mounted on a shaft rotated at a preset speed by a 0.5 hp variable speed motor. The outer sheath of banana pseudostem is fed in between the two rotating rollers, at 150 rpm. As the outer sheath passes between the two rollers, the sheath is split into various strands. The rollers are to be changed for different width of strands of sheath required viz., 2mm, 3mm and 4mm. The cost of the machine is Rs. 20000 and capacity of the machine is 3-3.5m/min and cost is Rs. 20,000/- (approx.).

b) Equipment for twisting and winding of splitted strands from outer sheath of banana pseudostem

The equipment contains a mechanism for twisting and another mechanism for winding the twisted strands on four bobbins through a bobbin building mechanism. Provision is made to vary the number of twists with the help of speed control mechanism, based on the requirement of the end product. Two 0.25 hp single phase motors with suitable power transmission mechanism are provided to operate the drawing, twisting and winding mechanisms. The twisted rope is used for production of various eco-friendly handicraft materials like bags, window curtains, table mat etc which has huge demand both in local and international market. The equipment enables uniform twist, low space requirement, less dependency on skilled labour, cheaper than manual labour and higher output. The capacity of the equipment is 4800 m/day and cost is Rs. 90,000/- (approx.).

The above package of equipment would greatly help in value addition from banana waste and the total value of the produce generated from this waste would be about Rs 1,00,000/- per hectare.

I.8 Post-harvest mechanization package for *Garcinia cambogia*

The package of equipment for processing of ripe *Garcinia cambogia* to juice concentrate/vinegar consists of Garcinia juicer/grinder, juice squeezer and juice concentration unit.

- a) **Juicer Grinder:** For extraction of juice, the garcinia fruit is ground finely by a high speed stainless steel, six blade juicer/ grinder (2800 rpm) with 2 hp single phase/three phase motor. The set of six blades are fixed to the rotating drive shaft. It has a tight lid on the top. Provision has been made to tilt the juicer for easy unloading after grinding. The capacity of the machine is 4 kg/batch and 40-45 kg/h, and cost is Rs. 30,000/- (approx.).
- b) **Juice Squeezer:** The ground paste of garcinia fruit is fed into juice squeezer for hygienic extraction. The capacity of the machine is 2 kg/batch or 40-45 kg/h and cost is Rs. 15,000/- (approx.).
- c) **Juice concentration unit:** The extracted juice is concentrated in the juice concentrator of stainless steel wherein heating is done by LP gas by two gas burners provided at the base of the juice holding container. The container is rotated at about 100 rpm with the help of 1 hp single phase motor. Provisions are given to scrape the concentrating juice both at the side and bottom of the container with the help of adjustable Teflon/ nylon scraper. Provision has been made to tilt the juicer for easy unloading after grinding. The capacity of the machine is 30 l/batch and cost is Rs. 70,000/- (approx.).



II. AICRP ON FARM IMPLEMENTS AND MACHINERY (FIM)

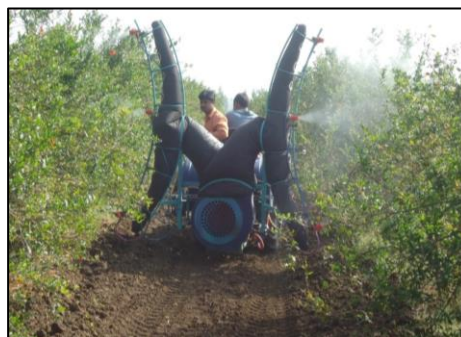
II.1 Tractor operated check basin former

Tractor operated check basin former scrapes, collects and distributes the collected soil uniformly to form side bunds and cross bunds at regular interval of 6 m in a single pass forming check basins of 2x6 m size with an effective field capacity of 0.15 ha/h. The cost of the equipment is Rs. 65,000/- (approx.) and cost of operation is Rs. 3073/ha. The net saving over conventional method is Rs. 1427/ha with a time saving of 96% in comparison to manual operation.



II.2 Pomegranate spraying system based on ultrasonic sensors

Pomegranate spraying system based on ultrasonic sensors equipped with sensor, programmer and non-return valve has an effective field capacity of 0.9ha/h with 1370 plants covered per hour. The unit price of the machine is Rs. 3.5 lakh. The saving of liquid varies from 25-30% and 45-50% with turbo nozzles and hollow cone nozzles, respectively.



II.3 Tractor operated cassava harvester

Tractor operated cassava harvester for digging and harvesting of cassava has an effective field capacity and field efficiency of 0.08 ha/h and 81%, respectively. The cost of machine is Rs. 30,000/- (approx.). The cost of operation is 2380 Rs./ha, having saving of 40% and 88% saving in labour cost as compared to conventional method for single row unit.



II.4 Tractor drawn turmeric rhizome planter

The tractor rear mounted turmeric rhizome ridger planter consists of 3 ridger bottoms and planting mechanism for planting on one side of the ridges in one pass. The planting mechanism includes rhizome hopper, cup feed seed metering mechanism, rhizome metering shaft, shoe type furrow opener and spike tooth ground wheel with chain sprocket drive for transmitting power from ground wheel to rhizome metering shaft. The row to row spacing of the planter is adjustable. The effective field capacity of the unit is 0.15 ha/h and its cost is Rs. 45000/- (approx.).



II.5 Power operated sugarcane sett cutter

Power operated (0.75 kW, 1440 rpm, single phase electric motor) sugarcane sett cutter, cuts single eye bud or double eye bud setts of sugarcane. The capacity of the developed cutter is 3360 setts/h. Time required to cut setts for one hectare by the developed machine is 8.24 h. The cost of machine, cost of operation and time saving over manual operation are Rs. 75000, Rs. 98/h and 80%, respectively.



II.6 Power operated garlic stem and root cutter

A power operated garlic stem and root cutter has been developed which is equipped with 0.75 kW electric motor. The mean output capacity with plain type cutter only for one side of the feeder box is 33.9 kg/h while it is 31.2 kg/h for serrated type cutter. The mean cutting efficiency is 99.2, 99.1 and 98.9% for small, medium and large size bulbs respectively. The power requirement of cutting stem and root is 1.2 kWh.



III. AICRP ON ERGONOMICS AND SAFETY IN AGRICULTURE (ESA)

III.1 Pedal cum power operated arecanut dehusker

A pedal cum power operated arecanut dehusker has been developed based on anthropometric data of workers and mechanical design parameters for better man machine system efficiency. The mean value of the heart rate of male workers operating the unit is 127 beats/minute, indicating that the unit can be operated comfortably by workers over a long period of time. In case of pedal operation, two workers are needed for its operation, one for pedaling the unit and another one for feeding arecanuts. The mean values for dehusking efficiency, kernel breakage and dehusking capacity are 97%, 7% and 15 kg/h, respectively. In case of 0.5 kW single phase electric motor dehusking efficiency, kernel breakage and dehusking capacity were 98%, 10% and 20 kg/h respectively. The unit costs Rs. 26,000/- (approx.).



III.2 Spraying safety kit

The efficient spraying safety kit consists of a face mask, a pair of gloves, eye protector, and an apron. For chlorpyrifos pesticide, the filtering efficiency of this face mask is 84%. The mask is comfortable to wear as the temperature rise inside the mask is around 2 °C and the breathing resistance is 0.7 m bar only. The PVC gloves identified has a good wearing as well as gripping comfort. The selected eye protector is made up of plastic frame with fibre glass ocular, and the wearing and visual comfort is good. An apron made from water proof polyester allows only



1.5% of pesticide penetration and 6% rise in temperature during spraying trials. The cost of the spraying safety kit is Rs. 650/- (approx.).

III.3 Tractor cab based on ergonomical consideration of Indian operators

The cab for tractor based on anthropometric data of Indian tractor operators consists of a cabin mounted on the existing tractor and fitted with CRC pipes and CRC sheets with silicon rubber fittings. One door on LHS, two windows, one on RHS and one on rear side is mounted with one step at entrance of door. Front headlights, front and rear indicators, rear side view mirrors are provided on each side of cabin. Air conditioning system is installed inside the cabin. Adjustable rear view camera is provided alongwith lighting arrangement and monitor inside cabin. The cost of the developed tractor cab is Rs. 2.5 lakh (approx.).



IV. AICRP ON UTILIZATION OF ANIMAL ENERGY (UAE)

IV.1 Animal drawn biasi plough

A biasi plough for weeding and thinning of plants in paddy crop grown under the biasi system of rice cultivation has a field capacity of 0.11 ha/h with 3-tyne biasi plough. The biasi plough made of mild steel has dimensions of 800 x 500 x 850 mm and the weight along with the beam is 40kg. By using this plough, the farmer saves Rs. 1825 per ha cost and 356 MJ/ha energy as compared to indigenous plough. The weeding efficiency with biasi plough is about 66% and the cost of the unit is Rs 1400/-.

