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DESIGN TEAM REPORT ON

FARM EQUIPMENT MANUFACTURING

TECHNOLOGY CENTERS

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Subproject

FARM EQUIPMENT MANUFACTURING TECHNOLOGY CENTRES

(F E M T C)

By

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INDIAN COUNCIL OF AGRICULTURAL RESEARCH

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I. SUMMARY

Dr. Anwar Alam, Assistant Director General, Agricultural Engineering, Indian Council of Agricultural Research and Dr. T. P. Ojha, Director, Central Institute of Agricultural Engineering, Bhopal prepared a study tour for the design team to the south of Delhi and another to the east. A large number of institutions and manufacturers related to farm mechanization discussed the reasons why research prototypes were not being manufactured and sold to farmers.

The overall objective of this subproject is to increase farm production through improved field and farmstead mechnization. A Coordinating Cell is to be established at CIAE, Bhopal with Farm Equipment Manufacturing Technology - Centres for the north at Ludhiana, central at Bhopal, and south at Coimbatore. A major factor in selecting the Project Director and the Project Engineers is their committment to take all necessary action to bridge the current gaps between research engineers, manufacturers and farmers. The subproject leaders accept the responsibility of the entire chain of events from machine selection to quantity sales of new machines to farmers.

Several new approaches are used to insure that past constraints are overcome in a timely manner. Most of these relate to developing better working relations between various groups involved in the adoption of new machines. Centre engineers will study the interests, actions, and motivations of both farmers and manufacturers to determine how the three groups may work together more effectively. The agricultural engineers will combine their knowledge of machine functions with the skills of production engineers to make production models which are functional, durable, and of reasonable cost.

A major emphasis will be given to developing and strengthening farm machinery trade associations to accelerate the adoption of new machines. State farm machinery trade associations will receive support through the project to hold workshops and visit factories of trade associations in other states. U. S. consultants will also be made available thorugh the project, to these trade associations to assist manufacturers with specific problems related to the introduction of new types of machines in their states.

Professional Agricultural Enginnering societies will be encouraged to play a catalytic role in this subproject. The Project Director and Project Engineers will follow through on each of the seven objectives; selection or planning of products, product development, improved manufacturing processes and practices, better purchased materials and parts, improved product quality, improved distribution of new machines, and better use of new machines on farms.

II. SUBPROJECT DEFINITION

A. BACKGROUND SETTING

The progress of agriculture through the centuries has been dependent to a large degree on the innovation of scientists and technologists and on the efforts of farmers to make the land more productive. Agricultural production, as in industry, depends on the application of power to materials whether the power is human, animal, mechanical or electrical. In India, approximately 70% of the population is engaged in agriculture. The male and female human work force is approximately 112.3 million and 35.7 million respectively while there are approximately 83 million draught animals.

Agriculture is seasonal and most of the 75% cultivated land area depends on monsoon rains under unirrigated conditions and produces only one crop confined to 100 to 150 days. The requirement of human labor varies from 3 man days to 18 man days per hectare on an average during the various months when the crop is grown. It is difficult to utilize the agricultural work force effectively and continuously throughout the year when the requirement varies by a factor of about 6 from the lowest to the peak demand period. This results in labour scarcity during peak periods of sowing, transplanting, and harvesting. To carry out these operations efficiently within the season bound period of time, improved agricultural implements and machinery are of great practical and economic value. Providing mechanization enables the peak labour demands to be met by increasing productivity but income and employment opportunities also increase.

Appropriate agricultural mechanization has played a significant role in developing the agriculture of India. Additional substantial progress must be made in a number of areas if the rate of productivity is to be maintained. There have been several key aspects of mechanization that have made a positive impact on productivity. The use of 10 million pumping sets (electric and diesel) has been important in increasing productivity. As the inputs of irrigation, seed of high yielding varieties and fertilizer have increased productivity there has also been a resultant increase in the importance of completing key agricultural operations in a timely fashion. Multiple cropping, made possible by improved inputs, is dependent on mechanized harvesting, threshing and tractor plowing to get one crop off the land and the second crop planted in time to realize maximum yields.

Increased productivity of land and labor due to mechanization is accepted by policy makers and realized by farmers in India. Selective mechanization is considered feasible and appropriate for small farm holdings. Efforts to improve the small farm level of mechanization are being concentrated on by government agencies.

Agro-Industrial Corporations were established in almost all the States of India with the aim of catering to the farm equipment needs of small farmers. The Agro-Industrial Corporations abandoned the manufacture and distribution of agricultural machines almost entirely because manufacture of tools and small implements was not commercially profitable due to low price and low profit per unit, disperse demand, complexities of distribution, and resultant high marketing costs.

Now tools and implements must be manufactured by enterprises with low investments and in areas where they will be used to simplify distribution and provide effective after sales service. Such enterprises can produce only region-specific tools and equipment in numbers determined through continuous interaction with the farmers.

The National Commission on Agriculture reported in 1976 that crop yield increases as the per hectare power input is increased up to a certain limit after which the rate of increase is constant. The limit has been reported to be 0.87 hp/ha. Examination of the farm power available in five representative districts situated in different agro-climatic zones has revealed a shortage of power during sowing and harvesting in four of the regions. The commission has stressed the need for selective mechanization and introduction of time and labor saving equipment to free the farmers from the tedium of normal operations and enable timely operations to be completed within appropriate limits.

There are 127 agroclimatic zones identified within India and studies have been undertaken to identify the key constraints to increase agricultural productivity in each. Alam (1984) outlined the objectives of mechanization in India as one or more of the following:

1. Increase in productivity of land and labour by

   a. timeliness in operation,
   b. increase in work output per unit time,
   c. increase in work output per unit effort,
   d. removing deficit of power/energy of conventional needs,
   e. improvement in quality of work done,
   f. precision in operation for better responses of inputs.

2. Conservation of inputs by

   a. precision metering of inputs for better distribution and reducing the quantity needed,
   b. precision placement of inputs for better responses,
   c. prevention of spillage and waste of inputs.

3. Reduction in unit cost of production through high productivity and input conservation.

4. Removing drudgery/hazards to humans and animals.

5. Imparting dignity to work.

In a more recent study Singh and Ojha (1986) analyzed the delivery system for farm machinery technology in India and concluded there is a pressing need to improve coordination of technology transfer between Research and Development (R&D) institutions and manufacturers. The farm machinery sector is not unique in having a need for improved technology transfer from public sector research facilities and the private sector companies responsible for application of technologies to benefit the society.

There has been a substantial effort in India during recent years to develop a variety of agricultural tools and implements. After reviewing relevant literature including numerous government reports and interviewing people active in the farm mechanization, it is clear little research technology results are reaching the manufacturers and farmers.

Currently, the most widely utilized agricultural equipment includes powered pump sets, sprayers and dusters, tractors and power threshers. Reapers are beginning to make an appearance in some areas. In addition to these items there is a need for further wide-scale development and adaptation of machines, implements and tools. Work has been done on assessing the technical and economic feasibility of appropriate technology. The publication on Bankable machines describes 100 machines for post harvest operations ready for wide scale application, but only a few are being manufactured and sold to farmers in satisfactory numbers.

Sources: Alam, Anwar, Selective Mechanization for Improving Crop Intensity and Crop Productivity, Proceedings of FAI National Seminar, 1984.

Table 1. ALL INDIA AREA, YIELD AND PRODUCTION OF PRINCIPAL CROPS

Crop	1983-84 Area '000 ha.	1983-84 Yield Kgs./ha.	1983-84 Production '000 tonnes	1985-86 Production '000 tonnes
Rice	40,990	1,485	59,768	64,150
Wheat	24,395	1,851	45,148	46,880
Jowar	16,263	734	11,934	N.A.
Bajra	11,810	646	7,624	N.A.
Maize	5,888	1,346	7,924	N.A.
Other Coarse Cereals	7,590	855	6,490	N.A.
Total Cereals	106,936	1,299	138,888	137,500
Total Pulses	23,412	541	12,655	12,960
Total Foodgrains	130,348	1,163	151,543	150,460
Sugarcane	3,167	55,904	177,020	175,000
Groundnut	7,641	953	7,284	N.A.
Soybean	814	716	583	N.A.
Other Oilseeds	10,240	483	4,947	N.A.
Total Oilseeds	18,695	685	12,814	11,200
Cotton*	7,765	144	6,582	8,550
Potato	806	15,200	12,200	
Total Crops	174,130			

N.A., Not Available
*Production in bales of 170 Kgs.

Sources: Indian Agriculture in Brief, 20th Edition, Ministry of Agriculture.
INDIA - Agricultural Situation, Attache Report, Feb 1987, FAS, USDA.

The crops grown determine both the need for equipment to perform farm operations and the ability to pay for the equipment from crop sales. The above principal crops account for over three-fourths of all land in crops. The three Centres should concentrate primarily during the subproject period on mechanizing these crops because of the greater potential for widespread adoption of the equipment. Soybeans have been included even though they are grown in a much smaller area than the other crops listed. However, they rank just behind groundnuts in yields and the country is trying to produce more vegetable oils and proteins. Also, farmers who start growing a new crop are much more receptive to adopting new methods and equipment. Equipment for other crops deemed to be a priority can be added after due consideration of the opportunity for economical adoption of the equipment by farmers.

Table 2. ALL-INDIA FARM SIZE DISTRIBUTION, 1980-81

Size of Farm ha	Number Million	%	Area Million ha	%	Ave Size ha
Below 1, Marginal	50.52	56.5	19.80	12.1	0.39
1-2, Small	16.08	18.1	22.96	14.1	1.43
2-4, Small-Medium	12.51	14.0	34.56	21.2	2.76
4-10, Medium	8.09	9.1	48.34	29.7	5.97
10 & Over, Large	2.15	2.4	37.13	22.8	17.24
Totals	89.35	100.0	162.79	100.0	1.82

Sources: Agricultural Mechanization in India, Status and Approach, R. S. Doharey, ISAE, March 1987.
T. P. Ojha, April 1987.

Farm size influences both what farm equipment a farmer needs and his ability to produce enough to pay for it. As a generalization, most farmers can not invest more in farm mechanization than a single years sales of his farm produce if he is to use it on his farm alone. Many Indian owners of tractors, pumpsets, threshers, and power tillers have paid for them through doing custom hiring for their neighbors to overcome this size constraint. In general, tractors must be used on more than 10 irrigated hectares, power tillers on more than 4 irrigated hectares, and pumpsets on more than 2 irrigated hectares to make them economically practical. If the land is rainfed, the area must be proportionately larger.

India has 83 million draught animals, 92.5 million cultivators, and 55.5 million farm labourers. Pumpsets currently provide 38% of power used on farms, draught animals 28%, tractors 22%, and human labour 12%.

Table 3. ALL-INDIA FARM MECHANIZATION POPULATION AND INVESTMENTS, 1984-85 ESTIMATES

Equipment	Units on Farms	Investment % of Total
Bullock Drawn Wooden Plow	40,000,000	1.9
Bullock Cart	13,250,000	10.3
Electric Pumpsets	6,500,000	17.1
Diesel Pumpsets	3,600,000	14.3
Threshers	900,000	3.6
Power Tillers	24,000	0.4
Farm Tractors	881,000	44.7
Tractor Cultivators	550,000	2.2
Tractor Disc Harrows	300,000	1.4
Tractor Trailers	400,000	3.2
Tractor Seed Fertilizer Drills	250,000	0.5
Combines	3,100	0.4
Total		100.0

Sources: Selective Mechanization for Improving Crop Intnsity and Crop Productivity, AGS 1-5, Anwar Alam, ICAR.
Status of Farm Mechanization in India, M. M. Mehta, Budni, Nov 1986.
Farm Machinery and Energy Research in India, No. CIAE/82/32, Bhopal, C. R. Shanmugham.
T. P. Ojha and Roy Harrington, April 1987.

Indian farmers have made their investments in farm mechanization wisely. About one-third of these investments have been in pumpsets because irrigation greatly increase yields and permits multiple cropping. About one-half of investments have been in tractors and implements for tillage and transport to permit timely operations for multiple cropping. Threshers outnumber tractors and have replaced most bullock trampling of wheat. The wooden plow is the most populous bullock drawn implement but bullock carts represent a greater investment.

Both private and government manufacturers are well developed for pumpsets, tractors, combines and power tillers. Therefore, the Centres will only work on equipment less costly than these.

Table 4. TOTAL FOODGRAIN YIELDS AND PURCHASED INPUTS BY STATES (1983-84 or Latest Data)

State	Foodgrain Yields Kg/ha	Fertilizer Use Kg/ha	HYV % of Crop	Tractors Per 1000 ha	Pumpsets Per 1000 ha	Cropping Intensity %	Farm Size ha
Punjab	2837	149	96	41.0	134	161	2.74
Haryana	1657	59	60	27.3	91	152	3.58
Kerala	1621	45	16	5.1	219	131	0.49
West Bengal	1481	45	43	0.7	29	137	0.99
Uttar Pradesh	1414	68	47	8.1	85	143	1.05
Tamil Nadu	1327	87	52	5.0	251	121	1.25
Jammu & Kashmir	1321	26	62	2.6	2	136	1.07
Andhra Pradesh	1279	69	34	3.9	93	114	2.34
Himachal Pradesh	1227	19	75	2.5	4	165	1.63
Gujarat	1159	47	21	9.1	207	112	3.71
Bihar	1062	27	44	2.9	46	134	1.11
Assam	1055	5	26	1.5	2	130	1.37
Orissa	1005	13	20	0.7	7	143	1.60
Karnataka	1003	45	19	3.3	67	108	2.98
Madhya Pradesh	840	15	19	2.2	32	114	3.58
Rajasthan	763	12	14	4.3	27	114	4.65
Maharashtra	752	32	29	2.7	78	111	3.66
ALL INDIA	1162	45	32	6.2	71	124	2.00

Sources: Status of Farm Mechanization in India, M. M. Mehta, Budni, Nov 1986.
Indian Agriculture in Brief, 20th Edition, Ministry of Agriculture.

Foodgrain yields vary widely within the country with moisture availability as a key determinant. If moisture is available naturally or by irrigation, then the farmer can risk investing in fertilizer and High Yielding Varieties. Foodgrain yields of the three lowest states are only half those of Haryana and less than one-third those of Punjab. There is a good correlation between yields and the adoption of both fertilizer and HYV. Among the nine states with above average yields, seven have above average fertilizer use and eight have above average adoption of HYV. Farmers with above average yields have added income to purchase more inputs to further increase yields and income. Fortunately, both fertilizer and seeds may be purchased in small lots and the benefit comes in the same year.

Tractor power has contributed greatly to the high yields and high cropping intensity of Punjab, Haryana, and Western U.P. Without this added power, the irrigated farmer would have time constraints in ha vesting one crop and sowing the next that would reduce his total farm production. Unfortunately farm equipment is a lumpy input which can not be scaled down simply to meet India's relatively small farm sizes. Farm equipment is not consumed during the year of purchase so the return on investment is much slower than for fertilizer and seeds. In spite of these difficulties, Indian farmers have adopted tractors and pumpsets in much greater quantities than had been anticipated. Farmers with holdings too small to pay for a tractor can readily get help from a neighbor through custom hiring. Thus custom hiring has overcome to a considerable extent the farm size problem. The problem of delayed return on investment has been alleviated by the availability of credit for the purchase of farm equipment.

More recently power tillers have become popular in some irrigated rice growing areas as a lower cost option than tractors. There are now over 1,000 unfilled orders for power tillers in the West Bengal districts of Burdwan, Hoogly, and West Midnapur. Small farmers in these districts do custom hiring for Rs. 40-45 per hour and in the peak season run their tillers three shifts per day. Other farmers can afford hiring them because it permits them to follow rice with potatoes and in many cases get a third crop per year.

Since the purchase of fertilizer and improved seeds generally have a more obvious payoff than mechanization, the Centres should work first with farmers who have adopted these inputs and are ready to consider further improvements in farm management. Farmers doing multiple cropping must have sufficient power and improved implements to reduce their time constraints.

B. STRATEGIC PLANNING FOR MORE PRODUCTIVE FARM MECHANIZATION REQUIRED STEPS IN THE INTRODUCTION OF NEW PRODUCTS

1. PRODUCT PLANNING

A better understanding of farmers felt needs which cause him to purchase machines is required. The biggest purchase has been pumpsets because irrigation offers independence from the undependable and often inadequate monsoon rains. Pumpsets offer both higher and more dependable yields making it practical for the farmer to invest in fertilizer and new varieties which further increase yields. Pumpsets also offer the opportunity to do multiple cropping of two or three crops per year.

Tractors have been and are being purchased in large numbers, even by farmers with holdings too small to justify their purchase. They pay for the tractor by custom hiring for other farmers. Tractors are popular because they replace bullocks for tillage which is the highest draft and most time consuming cropping operation. They also replace bullocks for transport as tractors are much faster and can go to markets farther from the village. Tractors remove drudgery and offer dignity to work.

After many years of slow and erratic sales, it appears that power tillers will now take their proper place in Indian agriculture. They are most popular in the irrigated rice areas where they permit growing two or three crops per year in a timely manner. Custom hiring has helped overcome the small farm size problem.

Wheat threshers powered by pumpset engines and motors as well as by tractors are now selling in larger numbers than tractors. Threshers help avoid losses from fires and untimely rains, require less hard work in the hottest season of the year, and permit earlier sales of the grain.

Seed cum fertilizer drills have had lower adoption rates than tyne tillers, disc harrows, and trolleys but have been adopted in significant numbers because they give better precision in the placement and rates of seed and fertilizer which results in higher germination and higher yields. Significant yield increases have been attributed to adoption of this equipment.

Some hand tools have also experienced accelerated adoption recently. The groundnut decorticator is simple and dependable to operate, requires a fraction of the time of hand shelling, and has a reasonable cost.

From observing the motivation of the farmer and what he has adopted it is obvious the farmer will spend money if he can dependably increase his production through better moisture control, more timely operations for higher yields and multiple cropping, lower crop losses, and better precision of operations for higher yields. Engineers must concentrate on introducing equipment which the farmer recognizes will increase his income through higher production and sales.

Currently available studies which show time and labour constraints must be used. Farmers need to be surveyed as to what they see as their major operational constraints in farming. Farmers who have used wheat threshers for a number of years are now ready to purchase reapers. Conversely, there are some products engineers should not waste their time on because of limited opportunity to make significant improvements. The bullock cart is a good example. The market has been saturated for many years and the private manufacturers of various sizes offer the farmer rubber tires as well as traditional wooden wheels. Further improvements will come as a result of competition in the market place.

2. IMPROVED DEVELOPMENT OF PRODUCTS

The introduction of new farm machines within a given area is a difficult task. The engineer must first have a thorough understanding of the farm operation to be done. He must then become familiar with machines performing this operation in an improved manner which are being purchased by farmers in other parts of the country. The engineer must then obtain one of these machines and become a skilled operator. Then and only then is he prepared to conduct valid repeatable measured performance tests in the field and in the laboratory. The design team observed several instances during the study tours where a research engineer said a particular machine was not functional while the real problem was that he did not use the machine enough to learn how to operate it properly. When selecting new machines for trials in a new area, preference should always be given to those proven through repeated farmer purchases over those which have remained in the research institutes and are not farm proven.

Improved designs require a series of steps. (1) The first is functional performance. The machine must be operated in the field until it is adjusted to the point that it works well. Repeatable measured tests of its performance are then required to provide a base against which future design changes can be compared. (2) As functional performance is being developed, consideration must be given to ease of operation and maintenance. (3) Durability is the next consideration. The structure must be sufficiently strong for normal use. Drives must be adequate. Soil working parts and cutting parts need hardening to remain sharp. (4) While cost is a consideration throughout the design process, the previous steps are essential to have a marketable machine at any price. (5) After reasonable cost estimates have been made, the cost and the benefit per unit of work done by the machine must be determined to see how much work per year the farmer must do to make it economically viable.

The successful introduction of a new machine requires the intimate co-operation of the research engineer and the private manufacturer. The research engineer has more access to information on machines being sold to farmers in other parts of the country and has more engineering knowledge that permits him to run repeatable measured tests of functional performance. The manufacturer also has unique talents that must be used if new machines are adopted. Once he has started making a new machine, there is an incentive to improve quality and offer favourable prices to be more competitive and increase sales. While not all manufacturers recognize this, those who stay in the market for a long time will continue to improve product quality in both function and durability to maintain a competitive advantage. The manufacturer will learn from farmers what design and quality improvements are needed. The design team encountered several manufacturers who had upgraded their products to be more competitive.

3. IMPROVED MANUFACTURING TECHNOLOGY

After a design has been established, it must be manufactured at a reasonable cost if it is to succeed in the market. Manufacturing technology and good machine tools are readily available in the large scale sector in India but many of the manufacturers of farm machinery with 10 to 50 workers need assistance from trained, experienced engineers. Engineers can help determine which parts of the machine wear rapidly and thus require hard surfaces. They can also establish how to make repeatable, interchangeable parts through the use of templates, drill fixtures, weld fixtures, and gauges. They can assist in determining what inspections are required to make certain the farmer gets a quality machine that is ready to run. The small scale manufacturer has an incentive to improve manufacturing technology but the engineer can make a major contribution by helping him.

Specific examples are shown below where engineers can improve technology for small scale manufacturers. The design team observed most of these improved technologies in use by some manufacturers but their use needs to be more widespread.

A. Improved Purchased Materials and Parts

1. C70 to C90 steel for hardened soil working or cutting parts.
2. Cold rolled sheet metal for better forming.
3. Plated hardened bolts.
4. Zerk grease fittings.
5. Self-aligning bearings on thresher cylinder shaft.
6. Hardened reaper knife sections and guards.
7. Plastic or aluminium fluted feed on seed cum fertilizer drills.

B. Improved Manufacturing Processes and Practices

1. Production of repeatable, interchangeable parts
   a. Templates for cutting to size and shape.
   b. Drill fixtures to accurately locate holes.
   c. Weld fixtures to accurately locate welded assemblies.
   d. Guages to check part size and shape.
   e. Jigs to produce repeatable parts faster.

2. Options for hard surfaces for soil working and crop cutting parts
   a. Heat treat high carbon steel.
   b. Buy parts from Ludhiana or other manufacturers.
   c. Hard surface with welding rod.
   d. Add used truck springs for cutting edges.

3. Spot welding of sheet metal for better quality, lower cost.

4. Woodruff (half-round) or square keys for thresher shafts.

C. Improved Final Inspections of Machines

1. Check static balance of thresher cylinder assembly.
2. Check drive train operation and load.
3. Check uniformity of individual seed meters.
4. Check reaper cutting and conveying mechanisms.

4. IMPROVED DISTRIBUTION OF NEW MACHINES

Research engineers can speed up the adoption of new machines if they do more on-farm field demonstrations for demand generation or market development. These demonstrations can serve multiple purposes if the invited audience includes farmers, current manufacturers, potential manufacturers, agricultural extension engineers, and bankers. The demonstrations can help potential manufacturers and bankers assess the amount of farmer interest in the machines. The farmers can meet the current manufacturers and learn how they can buy the machines and be assured of continued service. The demonstrations can also help the current manufacturers and the extension agricultural engineers in learning how to conduct good demonstrations. In addition to field demonstrations, the research engineers can be an information source to both farmers and extension engineers as to what companies provide these machines.

5. IMPROVED USE OF NEW MACHINES

Farmers need training in the proper use, adjustment, lubrication, and maintenance of new machines. Initially the engineers should work with the manufacturers until they learn to provide their own training to farmers when the new machines are delivered.

Manufacturers also need help in understanding the importance of making interchangeable parts so the farmer may buy and install them without having to take the entire machine back to the manufacturer.

In the initial stages of adoption, the engineers can speed up design improvements by manufacturers by working with them to learn from farmer-users what improvements are needed for function, durability and cost.

C OBJECTIVES

The fundamental objective of the subproject is to improve agricultural productivity by increasing appropriate mechanization of critical field and farmstead operations. Farm equipment manufacturing and promotion centres are to be developed to undertake activities which will achieve the following specific supporting sub-objectives:

1. Develop a stronger linkage between research activities, manufacturing and crop production to reflect the farmers needs in the machines manufactured.

2. Improve the process of developing appropriate farm equipment by focusing attention on the most important items and the critical design features and management aspects.

3. Transfer improved manufacturing technology to manufacturers through better manufacturing processes and practices.

4. Improve the ability of manufacturers to select and obtain appropriate high quality materials and component parts.

5. Improve the quality of manufacturing and adoption of appropriate standards.

6. Improve the distribution system of new machines and replacement parts through better communication and cooperation between manufacturers and concerned state and central government agencies.

7. Improve the productivity and onfarm management of appropriate machines.

III. STRATEGY - COMPONENT ACTIVITIES

A. Establish three Farm Equipment Manufacturing Technology Centres to accelerate transformation of Applied Research and Development of agricultural tools and implements into industrial application and local production.

B. Translating field proven prototype designs into standardised production designs with emphasis on quality, simplification of parts, use of off-the-shelf components, and economy of materials.

C. Train manufacturers, farmers and appropriate government agency staff on operation, repair and maintenance of field proven prototypes selected for commercialization.

D. Create facilities for batch manufacturing of selected designs of farm implements for adaptive research, evaluation and manufacturer's prototypes to meet the needs and demands of farmers.

E. Develop templates, jigs, fixtures, and gauges applicable to selected prototypes and promote their use through training of small manufacturers.

F. Provide technical and economic consultancy and on-site assistance in developing small commercial manufacturing units.

G. Develop and extend farm mechanization technology to manufacturers and farmers through training, demonstrations, literature and public information media.

IV. IMPLEMENTATION

A. Farm Equipment Manufacturing Technology Centres:

Presently the Central Institute of Agricultural Engineering at Bhopal coordinates the All India Coordinated Project on "Farm Implements and Machinery" under which R&D and prototype manufacturing is carried out on a modest scale at 6 centres. The Institute also has an Industrial Extension Unit to assist manufacturers in solving problems related to production, materials, etc.

The CIAE besides having a Manufacturing Technology Centre will also coordinate the implementation of the FEMT sub-project.

1. COORDINATION COMMITTEE:

The overall implementation of the sub-project shall be coordinated by the Director of CIAE. Members of the Coordination Committee will include:

Deputy Director General, ICAR	Chairman
Asst. Director General (AE), ICAR	Member
Director, CIAE	Member
Project Coordinator, PHT Scheme CIAE	Member
Project Coordinator, FIM Scheme CIAE	Member
Head AIE Division, CIAE	Member
Dean CAE, PAU	Member
Dean CAE, TNAU	Member
Project Engineer,-TNAU	member
Project Engineer, PAU	member
Project Coordinator, Draft Animal Scheme CIAE	Mamber
Project Coordinator, Power Tiller Scheme CIAE	Member
Farmer Representative	Member
Manufacturer Representative	Member
Project Director	Member Secretary

The Committee will continuously monitor and evaluate the project activities and progress. Any constraints relative to cooperative implementation among the Centre will be attended to by the Committee. An Annual Workshop will be sponsored by the Committee to hear activity reports and prepare implementation strategy. The conference will be held at each centre on a rotational basis. The Committee will be responsible for evaluating and monitoring the program among the centres. Six months after each workshop the technical committee will meet at Bhopal to review the progress made by the various programmes. Members of the Technical Committee includes the ADG for Agricultural Engineering, Director of CIAE, Project Director and the Project Engineer from each of the three centres.

2. CENTRE ADVISORY COMMITTEE:

Each location will organize an Advisory Committee to monitor and guide the activities. The Committee shall be organized as follows:

Director of Research	Member Chairman
Dean of College AE	member
State Dept. of Agriculture (at Addl/Jt Director level [2])	Member
State Agro Industries (2)	Member
Senior Research Eng./Dept. Head	Member
Manufacturer (2)	Member
Farmer (2)	Member
Small Scale Industries (1)	Member
Project Engineer	Member, Secretary

The Centre Advisory Committee will be responsible for recommending implements to be promoted and manufactured within the activities of the Centre. The committee should meet at least once a year, about half way between annual workshops.

3. LOCATION OF CENTRES: Three Centres will be established at Bhopal, Ludhiana and Coimbatore and each centre will service the following designated states.

a. BHOPAL - Central Institute of Agricultural Engineering (CIAE)

1. Madhya Pradesh
2. Maharashtra
3. Gujarat
4. East Uttar Pradesh
5. Bihar
6. West Bengal
7. Orissa

b. LUDHIANA - Punjab Agricultural University (PAU)

1. Punjab
2. Haryana
3. West Uttar Pradesh
4. Rajasthan
5. Himachal Pradesh
6. Jammu and Kashmir

c. COIMBATORE - Tamil Nadu Agricultural University (TNAU)

1. Tamil Nadu
2. Kerala
3. Karnataka
4. Andhra Pradesh

B. COLLABORATING BODIES

The exchange of technical information will be supported through the identified universities, institutions and organizations as follows:

1. International Division of the National association of State Universities and Land Grant Colleges.
2. Office of International Cooperation and Development of the U.S. Department of Agriculture.
3. Indian Society of Agricultural Engineers
4. American Society of Agricultural Engineers
5. AICRP on Farm Implements and Machinery
6. AICRP on Harvest and Post Harvest Technology
7. AIE Division, CIAE, Bhopal
8. U.S. Farm and Industrial Equipment Institute
9. State Agricultural Implement Manufacturers Association.
10. Animal Utilization Association
11. Power Tiller Association

a. AICRP - Farm Implements and Machinery Scheme: The All India Coordinated Research Project on Farm Implements and Machinery was initiated in 1972. There are currently 16 major centres with coordination based at the Central Institute of Agricultural Engineering in Bhopal. These centres are:

1. Central Institute of Agricultural Engineering, Bhopal
2. Punjab Agricultural University, Ludhiana
3. Tamil Nadu Agricultural University, Coimbatore
4. Mahatama Phule Krishi Vidyapeeth, Pune
5. Andhra Pradesh Agricultural University, Hyderabad
6. ICAR Research Complex for NEH Region, Shillong
7. Indian Institute of Sugarcane Research, Lucknow
8. Bisra Agricultural University, Ranchi
9. Haryana Agricultural University, Hissar
10. G.B. Pant University of Agriculture and Technology, Pantnagar
11. Mohan Lal Sukhadia University, Udaipur
12. Gujarat Agricultural University, Junagadh
13. Indian Institute of Technology, Kharagpur
14. Kerala Agricultural University, Vellinkara
15. Indian Grassland and Fodder Research Institute, Jhansi
16. Jawaharlal Nehru Krishi Vishwa Vidyalaya, Jabalpur

b. OTHER RELATED INSTITUTIONS:

Activities of the selected institutions engaged in related activities important to the agricultural machinery and equipment sector may be summarized as follows:

1. Agricultural Universities (Regional/State): There are many agricultural universities in India, but, only 15 have agricultural engineering programs including agricultural machinery and equipment (Allahabad, Kharagpur, Pantnagar, Ludhiana, Coimbatore, Bhubaneshwar, Rahuri, Akola, Udaipur, New Delhi and Vellanikkara). Many R&D activities are primarily academic.

2. Agricultural Machinery and Equipment Associations: A number of Associations (example: Agricultural Machinery and Implements Manufacturers Association, Hyderabad, Agricultural Machinery Association of India, Small Scale Industries Associations, Agro Industries Association etc.) at a national/regional level, are interested to cooperate with CIAE in applied R&D and manufacturing promotion.

3. Bureau Of Indian Standards (BIS): BSI has standardized approximately 115 items/products (tractors /primemovers-13, Tillage-34, Seed/fertilizing-11, Crop protection-16, Pump-2, Harvesting and transport-8, Processing-10 and hand tools-17). CIAE is represented on the ISI agricultural machinery and tractors sectional committees. CIAE-BSI will play an important role to assist manufacturers in adopting standards, enhancing quality, reducing cost and improving reliability and performance.

4. Industrial Finance Institutions: The major financing to small scale industry to purchase capital equipment is done by industrial financial corporation, and for working capital through commercial banks.

5. Appropriate Technology Centres/Rural Development Centres: Some of the above centres are involved in some R&D of hand tools with limited facilities. They lack industrial liaison facilities.

6. Central Mechanical Engineering Research Institute (CMERI), Durgapur, C.S.I.R.: A selected group of agricultural engineers are engaged in the development of power operated agricultural machinery (such as tractors and tractor drawn implements). Punjab Tractors Ltd., is one of the major manufacturers who has taken design/technology from CMERI for commercialization.

7. National Institute of Design (NID), Ahmedabad: Modest work on the improvement of aesthetic appeal of agricultural equipment (power thresher in particular) has been started. It's activities are primarily in enhancing the aesthetic appeal and not original engineering design and development.

8. Khadi & Village Industries Commission (KVIC), Bombay: KVIC cover all rural industries and major work related to handloom, handicrafts, oil milling etc. The rural sector relevance to this project is in the area of rural post harvest technology and processing of oil seeds.

9. Small Scale Industries Development Commission (Central Govt.): SSIDC is under the Department of Industrial Development, Ministry of Industry, Government of India. They have a number of Small Industry Service Institutes (SISI) located in different parts of India and provide training and tool room facilities to small scale and rural industries. The services provided have not covered the agricultural implement and equipment sector on a significant scale. At District level, SSIDC has District Industries Centres (DIC) in selected districts in India. They provide raw materials and credit finances to small industries.

International Collaborating Institutions:

1. International Rice Research Institute (IRRI), Los Banos, Philippines.
2. Regional Network for Agricultural Machinery (RNAM), Los Banos, Philippines.
3. National Institute of Agricultural Engineering, Silsoe, U. K.

V. PLAN OF WORK

A. COMPONENT OBJECTIVES

The fundamental objective of the subproject is to improve agricultural productivity by increasing appropriate mechanization of critical field and farmstead operations. Farm equipment manufacturing technology centres are to be developed at three locations to undertake the following component activities to achieve the specific sub-objectives. Description of the establishment of these centres follows this section under Personnel Levels, Training Programs, and Facilities, Materials & Equipment.

a. Develop a stronger linkage between research activities, manufacturing and crop production to reflect the farmers needs in the machines manufactured.

1. Review available studies on time and labour constraints by farm operation.

   Proper selection or planning of products requires an intimate understanding of the farmers needs. Increased power in the form of tractors and power tillers have primarily been purchased to provide more timely and better quality operations. A review of studies made in various parts of the country will help determine what needs to be mechanized next.

2. Survey farmers to determine their major operational constraints.

   Since the farmer is the ultimate decision maker in equipment adoption, it is essential that engineers learn what the farmers feel are greatest needs in their operations. Survey proforma should be prepared and used with both individual farmers and farmer groups.

3. Select a very limited number of farm operations to further mechanize.

   Introduction of new machines requires a very concentrated effort and thus demands that engineers limit themselves to working on a few implements so they can carry them to completion. The Coordinating Committee and the Centre Advisory Committees must limit the number of projects undertaken so that the machines get out of the museums and into widespread farm usage.

b. Improve the process of developing appropriate farm equipment by focusing attention on the most important items and the critical design features and management aspects.

4. For the farm operations selected in Activity 3, select machines to be further developed into production models.

   The centres will not become involved in the original design of agricultural implements. The Centre Advisory Committee should first seek out those machines being manufactured and used elsewhere in the country because they are farmer proven to be functional and make economic sense. In the absence of this type of machine being made anywhere in India, research designs approved for adoption may be used.

5. Purchase three or more units of the machines selected.

   For machines already in use elsewhere, the purchase should be made from manufacturers who have the best combination of machines sold and experience producing them. If a research machine is selected, it should be the one with the most time in the field with the best measured functional performance.

6. Learn to operate and adjust the machine for best performance in the field.

   Someone familiar with the machines operation should make certain the machine is giving its best performance. This is to be done by using a demonstrator from the manufacturer or the research engineer who designed and tested it.

7. Demonstrate the machine in several farmers fields.

   These demonstrations are to be conducted with the assistance of the manufacturer's demonstrator or the research engineer who tested it to be certain the farmers observe the machine operating properly. The audience for these farm demonstrations should include farmers, manufacturers, bankers, and extension engineers. Favourable farmer response will encourage manufacturers to consider making the machines and bankers to provide loans both to the manufacturers and to the farmers. Since extension work for implements has been inadequate, this is an opportunity to illustrate to extension engineers how to conduct good field demonstrations.

c. Transfer improved manufacturing technology to manufacturers through better manufacturing processes and practices.

8. Develop production designs while retaining functional performance, improving durability, and reducing cost.

At this time the agricultural engineers will have considerable field experience and the production engineers enough experience to understand functional performance. Working together, the machines functional performance will be retained but the machine will be modified for greater durability, easier manufacturing, and lower cost.

9. Develop improved manufacturing technology for use by small scale manufacturers.

Large and medium scale farm equipment manufacturers are already using several technologies which need to be transferred to smaller manufacturers. One of the greatest needs for quality improvement is the use of hardened surfaces for soil working and crop cutting parts. The centres need to determine how manufacturers can obtain suitable steel and how to dependably heat treat at reasonable cost for tooling. Alternatives must also be developed such as hard surfacing with welding rods, purchasing hardened parts from other manufacturers, and use of recycled car and lorry springs. Spot welding should be promoted for sheet metal on machines like threshers to improve fits and reduce production costs. Woodruff (half round) or square keys should be used on drive shafts to increae torque carrying capacity with less damage to the shaft than set screws.

10. Develop gauges, templates, drill fixtures, weld fixtures and other production aids to produce repeatable, interchangeable, quality parts.

The introduction of proper tooling is a major purpose of the subproject. The development of production aids will progress with the development of production designs described in Activity 8. Proper production aids help produce the machine as tested and designed, lower production costs through less scrap and less time spent measuring each part, and permit production of the same machine at a later time with less experienced workers. Interchangeable parts help the farmer do repair work without returning the machine to the manufacture. Manufacturers who are trained at the centres will participate in the development of production aids so they will know how to do it in their shops for other machines.

11. Manufacture gauges, templates, drill fixtures, weld fixtures, and other aids for use by small manufacturers of new machines.

    As a part of training, each manufacturer will make production aids needed to make the new machine he plans to produce. Other sets of production aids will also be made for sale to manufacturers of new machines who have previously completed training at the centres. While drawings of new machines should be available to manufacturers who want them, each manufacturer should receive a set of production aids when he begins manufacturing a new machine from the centres.

12. Create facilities for batch manufacturing of machines developed for production in Activity 8 at each of the three centres.

    One of the major activities of the manufacturing technology and promotion centre will be to provide small manufacturers, institutions, and farmers with quality prototypes. Designs developed, tested and approved for release will be produced for commercial multiplication. Appropriate component materials, cost optimization and efficient manufacturing techniques will be established to produce quality prototypes. Since relatively few small manufacturers read drawings, quality prototypes made at the centre will be provided to manufacturers for reference. Prototypes made by the centres will also be used for exhibitions and demonstrations. The facilities and the machine tools used in manufacturing these prototypes should serve as an example to small scale manufacturers.

13. Manufacture five production models to be used for measured field tests, field demonstrations, and transfer to manufacturers.

    Measured field tests of the first production models will be required to make certain no functional performance was lost in the modification for production. After performance has been verified, these five machines can be divided between field demonstrations for demand generation and placing with manufacturers for multiplication and sales. The production aids developed in Activity 10 and made in Activity 11 [illegible] to be used in the production of these five models to verif[illegible] their utility.

14. Train small manufacturers to produce new machines.

    During the third and fifth years of the subproject, each centre will conduct a 4-day training course for small scale manufacturers. Participants for training will be selected cooperatively between the centre staff and the Department of Industry/Agriculture. There will be a maximum of 20 participants in each course. Qualified classroom and applied instruction will

be provided jointly by the Centre Staff, Department of Industry Staff, and manufacturers. An honorarium will be given to instructors who perform beyond their normal assigned duties. While the Course Content will at least briefly cover all the material found in Appendix B, it will emphasize manufacturing technology along with the operation, adjustment, maintenance and repair of one or more new machines selected by the centre for commercial manufacture. Special interest will be given to heat treating steel and the construction of jigs and fixtures for the participants to take to their factories to make prototypes for the Centre to distribute among cooperating farmers.

15. Multiply production models for further popularization.

When production models are to be multiplied beyond the first few prototype units, substantial numbers of them should be obtained from private manufacturers. This will encourage them to take up the manufacture of new machines and make them active participants in their popularization on farms. After training, each manufacturer wanting to cooperate in the programme will produce significant numbers of production models with the assistance of Centre Engineers. These machines are to be evaluated for quality and performance by the Centre's Implement Evaluation Section. If the machines do not conform to appropriate quality and performance standards, centre engineers will assist the manufacturer in developing the skills required to make acceptable machines. If the manufacturer's first machines are acceptable, the Centre will purchase them to be used in farmer field test sites, for demonstrations, or to be sold directly to farmers. While it is useful to have the pilot plant operating at a reasonable load factor, it is the objective of this program that the centre will work its way out of production of a given unit as rapidly as possible so another can be taken up.

16 Provide on-site technical and economic consultancy assistance to manufacturers of new machines.

The Centre Staff will be available for technical and economic consultation to manufacturers on design, manufacturing technology, field demonstrations, and farmer training. They will also be available to farmers for the operation, adjustment, maintenance, and repair of new machines. Requests will be monitored to determine if the assistance needed relates to the general objectives of the subproject. The staff will also avoid spending too much time with any particular manufacturer or farmer while slighting others who need assistance. There will be no charge for consulting within the limits of responsibility of the staff. All consulting will be documented and responses filed in the Centre for reference and reporting.

d. Improve the ability of manufacturers to select and obtain appropriate quality material and component parts.

17. Select and obtain materials better than hot rolled mild steel where needed.

Manufacturers need to be trained as to when and how to use materials better than mild steel where needed for increased wear. Likewise cold rolled sheets should be used when required for better surface finishes or formability without cracking. Cold drawn rounds should be considered for drive shafts if they save machining.

Plastics need to be considered as an alternative to some parts currently being made of steel or wood. They can replace castings where greater precision and repeatability is required. Steel may be replaced if the shape is complex and requires many operations. Plastic may be less costly and more durable than wood.

18. Select and obtain standard off-the-shelf parts of good quality.

Plated and hardened bolts should be obtained from quality suppliers. Standard bearings, keys, and belts should also be purchased from quality suppliers.

19. Select and obtain field proven special farm machinery parts.

Some farm machinery parts require considerable tooling to obtain the required quality. Examples include disc blades from Karnal, reaper knife sections and guards from Ludhiana and fluted feeds for seed cum fertilizer drills. These should be made of aluminum or plastic for better precision.

20. Encourage manufacturers to make quality purchases.

When conducting training of manufacturers illustrate the difference in quality that can be obtained in materials and parts. Supply the manufacturers with names of quality suppliers of materials and parts.

21. Encourage the development of farm machinery trade associations

Each state and many districts should have farm machinery trade associations to promote faster farm mechanization. The centres should promote the development of these trade associations by offering them the use of their facilities for meetings, some clerical help, etc. Likewise, these associations should be invited to field demonstrations and other promotional events. The trade associations can also help the centres in selecting people for training and suggesting manufacturers to take up new machines.

Trade associations should be encouraged to hold workshops in other states with their trade associations to exchange experiences and observe other factories. These efforts can be supported through the project. U. S. consultants will be available to members of trade associations needing help in the production and introduction of new machines as an integral part of this project.

22. Encourage farm machinery trade associations to pool orders to obtain special steels or parts.

Much of the public and private sector supply industries are unaware of the total size of the farm machinery market. Thus they show little interest in the requirements of the small manufacturer for high carbon steels, and other special steels, materials and parts.. However, trade associations can collectively speak with a louder voice.

e. Improve the quality of manufacturing and adoption of appropriate standards. The stage manufacturers associations should be encouraged to play a key role in the following items:

23. Instill in the manufacturers the desire to make quality products.

During the training of manufacturers, obtain an instructor from a recognized quality manufacturer to stress that higher quality results in more sales and higher profits. Quality work by each employee is more effective than trying to get quality by inspection.

24. Develop the procedures for final inspection of quality.

Every machine should be ready to operate correctly before it is sold to the farmer. For power driven machines like threshers this requires several checks after assembly. The machine should meet safety and other related standards. The cylinder or any other heavy rotating part should at least be statically balanced. All machines should be checked for proper adjustment and frequent samples should be checked for functional performance. The complete drive train should be operated and the no-load power checked to determine if all parts are working freely.

25. Provide new manufacturers with help on proper inspection procedures.

After centre engineers have determined what is important to be checked, a proforma of needed inspections and how they are to be

conducted should be prepared for each new type of machine released. This should be furnished free to all manufacturers of the new machine. On-site consulting will also be needed for the first manufacturers of new machines.

f. Improve the distribution system of new machines and replacement parts through better communication and cooperation between manufacturers and concerned state and central government agencies.

26. Provide training to extension engineers, other government staff, bankers, etc.

Each centre will provide two 3-day training courses for extension engineers, government staff, bankers, and other persons related to the objectives of the subproject. The course will include an overview of agricultural mechanization, implements currently commercially available to farmers, economics of mechanization, operation of selected machines, and how to demonstrate and popularize new machines.

27. Provide training to farmers.

Each year each center will provide a 3-day training course for farmers. Participants will be selected cooperatively by the centre staff and the Department of Agriculture. A maximum of 20 participants will be in each course. The course will include the operation, adjustment, maintenance, and repair of one or more production models of new machines. Instruction and demonstrations will be performed by the Coordination Cell and the Centre Staff.

28. Provide a farmer field test site scheme for production models.

During the above training course, four farmers will be selected to participate in the Centre's farmer field testing program based on their interest and progressiveness. Production models selected for multiplication will be used by these farmers with assistance from the centre staff. Field performance data based on a standardized proforma will be measured and recorded by centres staff and the results publicized to manufacturers and farmers. Normally the test machine will remain a part of the farmers operation throughout one entire cropping season. Feedback information relative to the machine's performance and potential acceptability will be provided by the cooperating farmers to centre engineers. If the farmer wishes, he may purchase the test machine or a new one from a manufacturer.

29. Conduct timely, quality demonstrations of new machines.

To generate demand for machines farmers are not familiar with, demonstrations of these machines must be made in multiple states. The audience should include farmers, extension engineers, manufacturers, bankers, the press, and other interested parties. This is such an important activity of the subproject that two demonstration vans have been provided for each centre. These vans should be in continuous use during the season for either demonstrations or field tests. Farmers showing a keen interest in demonstrations may either request a demonstration on their farms or another machine be loaned to them for a short period with the requirement they report on its performance to the centre engineers. If sufficient models are available, farmers may buy the demonstration units. If not they should be encouraged to order from manufacturers.

30. Display new machines at farmers fairs (kisan melas).

Farmers fairs draw progressive farmers looking for new ideas. This provides the opportunity to expose new machines before a large receptive audience. Where possible the machines should also be demonstrated. Field test performance data should be shown in the local language along with announcements of future demonstrations in each state.

31. Provide publicity and promotion materials on new machines.

Farmers, manufacturers, extension engineers, bankers, and the press should be involved in the popularization of new machines. Some materials will apply to all groups while others must be prepared for special needs. All groups need to know how well the machines have performed and how much field experience has been accumulated. Farmers and extension engineers need to know where machines can be purchased and for what price.

g. <u>Improve the productivity and on farm management of appropriate new machines.</u>

32. Help manufacturers and extension engineers develop training for farmers.

While the centre should be involved in the training of the first farmers that adopt new machines, this task should be turned over to manufacturers and extension engineers after the machine has

been accepted commercially. One of the avenues for training manufacturers would be for them to be participants in the centre's training courses for farmers. Farmer adoption of new machines will be more rapid if they have been trained in the proper operation, adjustment, maintenance and repair the new machine.

33. Help manufacturers provide farmers with good service and repair parts.

Interchangeable parts are not only important in the original manufacture but also extremely important to the farmer customer when he must replace a worn out or broken part. The manufacturer and his dealers should always stock a reasonable supply of repair parts the farmer can install in his village rather than having to take the machine back to the manufacturer. The importance of this should be brought out in the manufacturers training and in on-site consultation.

34. Help manufacturers learn from customers how to improve their products.

The farmer test site scheme will provide feed back to the centres about potential improvements needed in the machines. Manufacturers should also select good progressive customers and seek their ideas on how the machines can be improved for function, durability and cost.

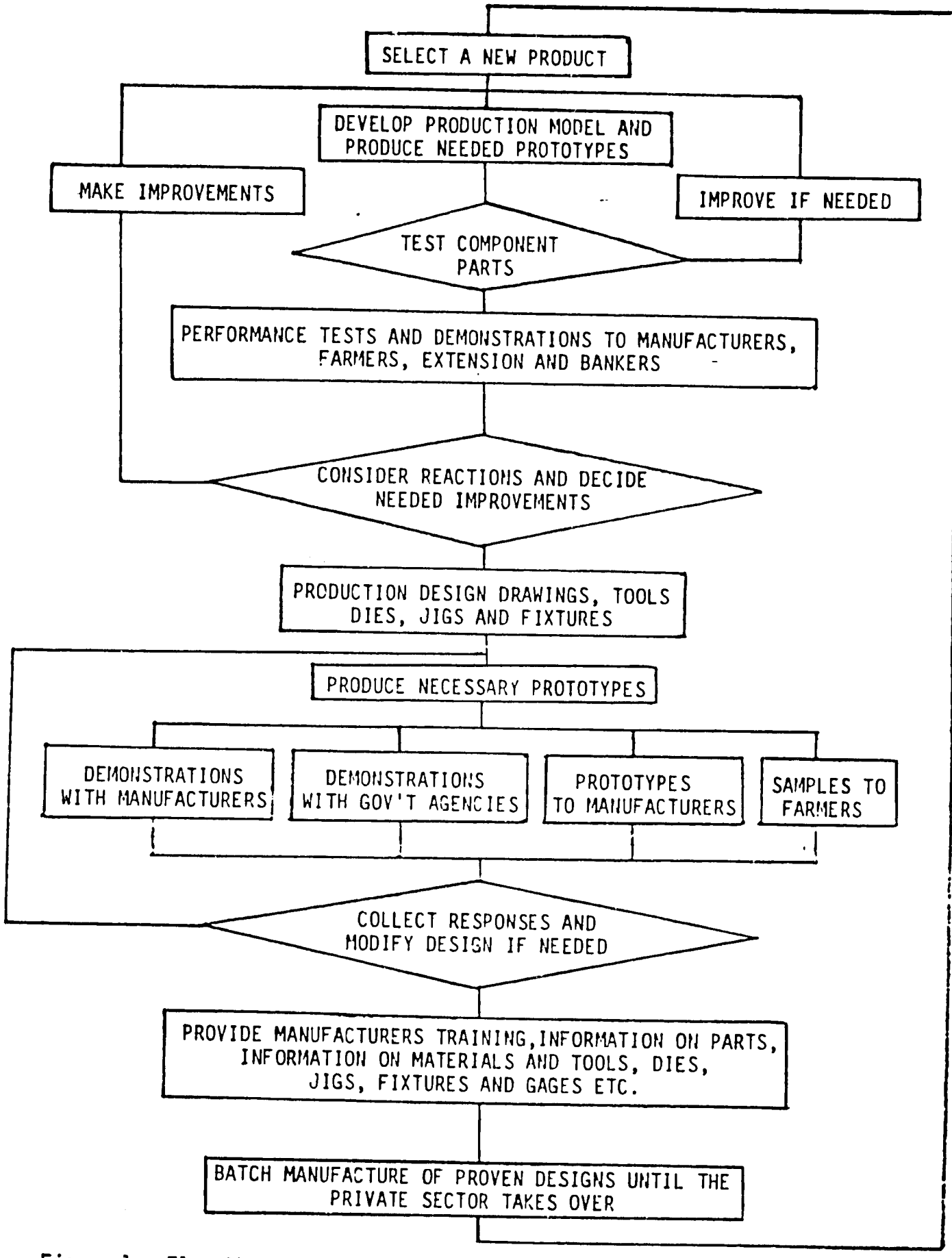

Figure 1. Flow Chart of Normal Sequence of Activity for a Given Implement

SCHEDULE OF ACTIVITIES

Activities to be performed by ICAR, the Bhopal Coordination Cell, and the Three Centres at Bhopal, Coimbatore, and Ludhiana to insure timely implementation of the subproject. This proposed schedule to be endorsed or modified as necessary at annual workshops.

No.	Subproject Initiation, Staffing, Training, Reviews	Location	Starting Date	Duration
1.	Subproject approval, budgeting, accounting	Delhi, Bhopal CC, Three Centres	Oct 1987	5 Years
2.	Staff procurement (Transferring locations and/or duties of existing staff and recruiting new staff)	Bhopal CC, Three Centres	Oct 1987	1 Year
3.	Professional Training (36 mm)	U.S.A.	Jan 1988	4 Months average
4.	Study Tours (2.5 mm)	U.S.A.	May 1988	1 Month
5.	ISAE Study Tour to ASAE ASAE Study Tour to ISAE	U.S.A. India	3 tours 3 tours	15 days each 15 days each
6.	On-the-job Training of subproject staff and manufacturers	Indian Manufacturers	Jan 1988	1 Month Repeated so only 2 staff per centre each time
7.	Project Workshop and Coordination Committee Review	Ludhiana Coimbatore Bhopal Bhopal	Apr 1989 Apr 1990 Apr 1991 Apr 1992	3 Days 3 Days 3 Days 3 Days
8.	Technical Committee Review	Bhopal CC Bhopal CC Bhopal CC Bhopal CC	Oct 1988 Oct 1989 Oct 1990 Oct 1990	2 Days 2 Days 2 Days 2 Days
9.	Mid-Term Review	Delhi, Bhopal CC, Three Centres	Apr 1990	3 Weeks
10.	Terminal Review and Report	Delhi, Bhopal CC, Three Centres	Jul 1992	2 Months

No.	Consultants	Location	Starting Date	Duration
1.	Key Consultant, U.S. Industry	Three Centres, Bhopal CC, Delhi	Mar 1989 Mar 1990 Mar 1991 Mar 1992	2 Months 2 Months 2 Months 2 Months
2.	Use of Gauges, Templates, Jigs and Fixtures Indian Industry Consultant	Three Centres	Jul 1988	10 Weeks
3.	Industrial Extension U.S. University Consultant	Three Centres or Bhopal CC	Jan 1989	10 Weeks
4.	Heat Treatment and Hard Surfacing Indian Industry Consultant	One Centre	Jul 1989	10 Weeks
5.	Manufacturing Technology for Small Scale Manufacturers U.S. Technical Institute Consultant	Three Centres or Bhopal CC	Jan 1990	10 Weeks
6.	Pattern Making & Foundry, Tool & Die Making Indian Industry Consultant	Three Centres or Bhopal CC	Jul 1990	10 Weeks
7.	Socio-Economic Impact Analysis U.S. University Consultant	Bhopal CC	Jan 1991	10 Weeks

* Fiscal provision shown in the coordinating cell budget.

No.	Facilities, Equipment, and Supplies	Location	Starting Date	Duration
1.	Development of Facilities (Remodel existing facilities or new construction where required)	Three Centres, Bhopal CC	Oct 1987	1 Year
2.	Purchase and Installation of Equipment	Three Centres, Bhopal CC	Oct 1987	1 Year
3.	Purchasing Supplies	Three Centres, Bhopal CC	Jan 1988	As Needed

No.	Component Objectives	Location	Starting Date	Duration
1.	Review Studies on Constraints	Three Centres Bhopal CC	Aug 88, 90	1 Month
2.	Survey Farmer Constraints	Three Centres	Sep 88, 90	1 Month
3.	Select Farm Operations	Bhopal CC	Oct 88, 90	1 Day
4.	Select Machines to Develop	Bhopal CC	Oct 88, 89, 90, 91	1 Day
5.	Purchase Three Units of Machines Selected	Three Centres	Nov 88, 89, 90, 91	1 Month
6.	Learn to Operate in the Field	Three Centres	Seasonal Annually	2 Weeks/or as needed
7.	Demonstrate Machine in Farmers Fields	Three Centres	Seasonal Annually	1 Month
8.	Develop Production Designs	Three Centres	Jan 1989	As Needed
9.	Develop Improved Manufacturing Technology	Three Centres	Feb 1989	4 Years
10.	Develop Production Aids	Three Centres	Mar 1989	As Needed
11.	Manufacture Production Aids	Three Centres	Apr 1989	As Needed
12.	Create Facilities for Batch Manufacturing	Three Centres	Apr 1988	6 Months
13.	Make Five Production Models	Three Centres	Nov 1989	2 Months
14.	Train Small Manufacturers	Ludhiana Coimbatore Bhopal	Jan 90, 92 Feb 90, 92 Mar 90, 92	4 Days 4 Days 4 Days
15.	Multiply Production Models	Three Centres	Apr 90, 91, 92	2 Months
16	Provide On-site Consultancy	Three Centres Bhopal CC	Feb 1990	As Needed

No.	Component Objectives (Continued)	Location	Starting Date	Duration
17.	Select Better Materials	Three Centres	Feb 1989	4 Years
18.	Select Quality Standard Parts	Three Centres	Mar 1989	4 Years
19.	Select Quality Special Farm Machinery Parts	Three Centres	Apr 1989	4 Years
20.	Encourage Manufacturers to Make Quality Purchases	Three Centres	May 1989	4 Years
21.	Encourage the Development of Trade Associations	Three Centres Bhopal CC	Sep 1988	4 Years
22.	Encourage Trade Associations to Pool Orders	Three Centres Bhopal CC	Oct 1988	4 Years
23.	Instill in Manufacturers the Desire to Produce Quality	Three Centres Bhopal CC	Oct 1988	4 Years
24.	Develop Procedures for Final Inspection of Quality	Three Centres	Dec 1989	3 Years
25.	Provide Manuacturers with Proper Inspection Procedures	Three Centres	Jan 1990	3 Years
26.	Train Government Staff, Bankers, etc.	Ludhiana Bhopal Coimbatore	May 89, 91 May 89, 91 Jun 89, 91	3 Days 3 Days 3 Days
27.	Provide Training to Farmers	Bhopal Ludhiana Coimbatore	Feb 1989 Mar 1989 Apr 1989	3 Days Annually
28.	Provide Farmer Field Test Site Scheme	Three Centres	May 1989	2 Months Annually
29.	Conduct Demonstrations of New Machines	Three Centres	Jan 1990	3 Years
30.	Display New Machines at Farmers Fairs	Three Centres Bhopal CC	Jan 1990	3 Years
31.	Provide Publicity & Promotion Materials on New Machines	Bhopal CC	Jan 1990	3 Years

No.	Component Objectives (Continued)	Location	Starting Date	Duration
32.	Help Others Develop Training for Farmers	Bhopal CC Three Centres	Feb 1989	3 Years
33.	Help Manufacturers Provide Good Service & Repair Parts	Bhopal CC Three Centres	Jan 1990	3 Years
34.	Help Manufacturers Learn How to Improve Their Products	Bhopal CC Three Centres	Jun 1990	2 Years

B. PERSONNEL LEVELS

Establish three Farm Equipment Manufacturing Technology and Promotion (FEMT) Centres to support ICAR, CIAE to achieve accelerated transformation of applied research and development into industrial application/local production.

Coordinating Cell: The CIAE unit in Bhopal will have the following staff to serve as the subproject coordinating cell for all three centres.

a.	Project Director, S-4 (FMP)	1
b.	Senior Agricultural Engineer, Industrial Liaison, S-3	1
c.	Senior Agricultural Engineer, Training, S-3	1
d.	Engineer/Economist, Techno-Economic Feasibility, S-3	1
e.	Sr. Draftsman cum Artist, T-6	1
f.	Stenographer	1
g.	Jr. Stenographer	1
h.	Jr. Clerk	1
i.	Messenger	2
i.	Driver	1
	Total	11

Coordinating Cell Staff Description

a. Project Director and Chief Agricultural Engineer, S-4 will coordinate the activities of all three centres. Reports of activities from all centres will be prepared for distribution to CIAE, ICAR and USAID. The Project Director will maintain Liaison with Manufacturer Associations, farmer groups, government institutions and agencies. These responsibilities will require a senior scientist with administrative as well as practical manufacturing and field experience.

b. Senior Agricultural Engineer, S-3 will serve as an industrial liaison and will develop and implement the project workplan. Considerable effort will be made to strengthen state Trade Associations and organize associations in states that do not have an organization. This responsibility will require considerable experience in manufacturing and agricultural machinery development. Assistance and consultation will be given to each centre as needed to develop commercial prototypes and promote improved manufacturing techniques.

c. Senior Agricultural Engineer for training, S-3 will be responsible for developing training materials and assisting each centre with training programs. The position requires a knowledge of the utilization of audio and video equipment, development of manuals and public relation materials.

d. Engineer/Economist for techno-economic feasibility, S-3 will relate the effects of Agricultural mechanization on the socio-economic behavior of farmers and villages. Surveys will be conducted relative to the effect of each machine before the machine is released for commercial production to determine the level of mechanization within a given area, to develop a date base and assist in planning for the necessary machines to be developed. He sill assist in coordinating State Trade Association and factory tours.

e. Senior Draftsman cum Artist, T-6, will assist in the development of training materials and manuals, appropriate sketching and development of training aids and exhibition materials to be used by each centre.

f. Stenographer will be responsible to the project director for dictation, typing, correspondence and filing.

g. Jr. Stenographer will be responsible to the scientists and other staff for typing and preparing training materials.

h. Jr. Clerk will do typing and diarising.

g. Messenger, one for project director and staff and one for the three S-3 scientist.

i. Driver will drive jeep for the project coodinator.

The three centers will be established at the following locations:

Location	Integrated Institution
Bhopal	Central Institute for Agricultural Engineering (CIAE)
Coimbatore	Tamil Nadu Agricultural University (TNAU)
Ludhiana	Punjab Agricultural University (PAU)

Substantial space, equipment and staff assigned to the all India coordinated project on farm Implements and Machines are located at each of the three proposed centres. The FIM Scheme has research objectives which are a precursor to and consistant with the objectives of the FEMT project. Existing resources should be applied to the new programme. It is recommended that substantial portions of the space, equipment and staff requirements of the FEMT project be met by reassignment and coordination of the FIM Schemes located at Coimbatore Bhopal and Ludhiana.

1. Bhopal: The Central Coordinating Cell and a FEMT Centre will be located within the CIAE infrastructure. The project director and coordinating Cell will be housed at the Bophal Centre. Space and facilities can be made available to be used by the sub-project. This will reduce the delay time for initiating the programme. Funds will be budgeted for remodeling the buildings and facilities to accommodate the sub-project.
2. Coimbatore The Centre will utilize land and some buildings and equipment made available by TNAU. The FIM Scheme staff and facilities should be merged into the FEMT Programme to the extent possible. Administrative responsibilities for the FEMT subproject by CIAE and TNAU will be defined by the respective agencies. Appropriate compensation and remodeling costs will be provided to TNAU in response to the use and/or acquisition of facilities.
3. Ludhiana: Resources related to PAU integrating with the FEMT Centre are adequate. Some buildings and equipment can be made readily available to the programme. Appropriate compensation should be provided to PAU by the FEMT sub-project for remodeling and arranging the building facilities. The manufacturing capability in the Punjab is considered more developed and could provide training staff or consultancies to the other Centres.

Centre Staff Requirements

Position	No.	Duties/Tasks
1. Project Engineer Scientist, S-3 (FMP)	1	Team leader, planning, coordination, supervision, liaison, documentation.
2. Agricultural Engineer Scientist, S-2 (FMP)	1	Testing and production of prototypes, field demonstrations
3. Senior Production Engineer, T-8	1	Development of production prototypes. Production process manufacturing tech. design.
4. Asstt. Production Engineer. S-1/T-6	1	Design of tooling, jigs and fixtures, inplant training.
5. Asstt Training and Demonstration Engineer S-1/T-6	1	Organize and execute demonstrations, training.
6. Training and Demonstration Assistant, T-4	2	Assist in training and demonstrations.
7. Foremen, T-7	1	Supervision of pilot Mfg. plant.

8. Senior Technician, T-I-3	4	Master craftsman in tooling, machining, welding, heat treatment moulding.
9. Draftsman, T-4	1	Drafting, blueprints, assembly & mfg. drawings, other illustrative materials.
10. Tracer, T-2	1	Tracing and blue printing.
11. Craftsman, T-1	12	Execution of fabrication/mfg. work in trades of machining, welding, fitting, foundry, plastic moulding, heat treatment, press operators, carpentry, painting.
12. Helpers	6	Physical assistance to craftsmen, material handling.
13. Drivers	3	One for jeep, 2 for two Demonstrations-cum-Training vans.
14. Stenographer	1	Dictation, typing, correspondence
15. Jr. Clerk	1	Typing and diarising/dispatch.
16. Accounting Clerk	1	Maintenance of financial accounts purchase of raw materials, store maintenance.
17. Messenger	1	
18. Store Attendant	1	
19. Safaiwalla (Janitor)	1	
Total	41	

C. TRAINING: The Centre staff will participate in the following training programs:

1. Professional Training: A total of nine (9) professional training scholarships will be provided by the project. Three scholarships up to an average of 4 months for technical training will be provided for each Centre. The recipients should have a minimum B.Sc. in Agricultural Engineering or equivilant. The program would be taken in the U.S.A. The curriculum will be designed under a special education technology program to provide courses and training that directly relate to the objectives of the project. The course of study will not be research oriented but technology implementation. A USAID consultant in the U.S. will organize the programmes and submit to the Indian government, ICAR for approval. (36 mm)

2. Study Tours: Nine persons including the Director of CIAE, ICAR-ADG responsible for the Subproject, Project Director and the Project Engineers from each Centre plus a representative manufacturer will visit selected agricultural machinery institutions and small scale manufacturers of agricultural tools, machines and implements abroad for a period of 25 days during the first two years of the project (7.5 man-months). Persons selected by the Indian Society of Agricultural Engineers will participate in an American Society of Agricultural Engineers meeting for 15 days during three years of the project (1.5 mm). Technical papers will be prepared for presentation by each participant plus integrating with U.S. individuals or institutions involved in related programs.

3. Practical Training for Centre Staff: India is fortunate to have some highly developed industries using modern manufacturing technologies. In order to improve the practical knowledge of the Centre staff and develop an integrated working relationship between institutions and manufacturers, a one month on the job training will be provided for each Centre staff with T-4 grades or higher through S-3 scientist, including the project leader. The training will include working with comparable grade employees of a progressive, well developed industry in the country, i.e. VST Tillers Tractor Ltd. in Bangalore and American Spring and Pressing Works in Bombay. An outline of the area and topics to be studied during the training period are attached as Appendix B. The Engineer/Economist for Techno-Economic feasibility scientist located at the Coordinating Cell in Bhopal should participate in a training program at IIM in Ahmadabad.

4. Trade Association Workshops: The Sub-project will sopnsor a workshop for trade association manufacturers annually for 4 years with a grant of Rs 50,000 (total 2,00,000 Rs) The workshop will identify and recognize outstanding manufacturers each year.

D. CONSULTANTS:

The implementation of the program will be enhanced by utilizing Consulting Specialists in designated areas of technology. The project should use National Consultants where the Project Advisory Committee can identify competent professionals that would be effective in accomplishing the objectives of the project. One key consultant will be attached to the project Coordinating Centre for 2 months each year for 4 years (8 man-months).

The Sub-Project will have the equivalent of 15 man-months of consultancy during the second, third and fourth years years of the project. These short term consultants would be selected from Institutions and/or manufacturers based on the area of expertise needed by the Centre. The Consultants will be experts in the area of industrial extension, manufacturing technology, foundry and heat treatment, jigs, fixtures, templates and impact analysis of mechanization. Expertise found among the Indian Universities or the manufacturing industry should be utilized when possible. The consultants should be utilized more during the first years of the project and reduced as the programme develops. An activity time chart for the suggested consultancies is attached. The project provides 23 mm of consultancy - 8 mm for key consultants and 15 mm for professional consultants.

E. STUDY TOURS:

One representative from the American Society of Agricultural Engineers will participate in the Indian Society of Agricultural Engineers annual meeting each year for 3 years for a total of 15 days per trip. The total exchange would be 1.5 mm.

Similarly, one representative from the Indian Society of Agricultural Engineers will attend the American Society of Agricultural Engineers annual meeting each year for 3 years for a total of 15 days per trip. The total exchange would be 1.5 mm.

Expenses will be provided for one person from the Indian Private manufacturing sector to study U.S. manufacturing technology for a period of three weeks each year for 4 years (3 mm). Expenses include: Travel to U.S. - $3,000.00 + Travel within the U.S. - $1,000 + DSA @ $100/day - $2,000 = Total of $ 6,000.00/visit.

Expenses will be provided for one person from the U.S. private manufacturing sector who will study the Indian manufacturing industry for three weeks each for 4 years (3 mm). Expenses include: Travel to India - $3,000, Travel within India- $1,000, DSA @ 100/day = Total of $ 6,000/visit.

F. FACILITIES, MATERIALS AND EQUIPMENT:

Land and some building space are available at each of the Centres. The building area requirements at each centre for workshops, quality control and testing laboratories training, and rooms for staff is estimated to be 1400 sq. metres (14,000 sq. ft.). A minimum of one hectare of land will be provided for-field evaluation of equipment. Total for all centres equals 4200 sq. metres (42,000 sq. ft.). In order to implement the project objectives, each centre will have a minimum of the following facilities:

1. Office space
2. Pilot manufacturing plant
3. Testing and Analysis Laboratory
4. Prototype modification workshop
5. Field evaluation space (one ha)
6. Classroom
7. Laboratory training space
8. Conference room
9. Information accumulation and dissemination
10. Storage
11. Tool room
12. Demonstration vans

1. Office space : A minimum of 5 offices will be provided for the professional staff and secretaries. Each office will be equipped with desks and furniture as needed. Three offices will be needed for the Coordinating Cell at the Bhopal Centre

2. Pilot manufacturing facilities : One of the major objectives of the manufacturing technology and promotion centre will be to provide small manufacturers, institutions, agencies and farmers with quality prototypes. Designs developed, tested and approved for release will be produced for commercial adaptation. Appropriate component materials, cost optimization and efficient manufacturing techniques will be used to produce quality prototypes. Since few of the small manufacturers have the capability of reading blueprints, quality prototypes developed by the centre will be provided to manufactures for reference. The prototypes developed by the Centre will also be used for exhibitions and demonstration purposes.

3. Testing Laboratory: Precision metallurgical and hardness testing equipment will be installed to determine the quality of materials used in manufacturing the implements. Other precision instruments will also be used in this controlled environment area. The XT Computer to be used by the Centre staff will require the controlled environment. Computer capability will enhance the operation of the Centres in a number of important aspects. A low-cost desk top PC computer can be used to document, prepare reports (word processing), record keeping for financial reporting and inventory analysis. A PC with two floppy disc drives supported by a corresponding quality printer should be located in the office area.

   A compatible desk top XT computer supported by a dot matrix printer and an XY plotter should be in the laboratory area. This computer will be used by the professional staff for utilizing a variety of available software helpful to the project. Some of the software needed includes the economic analysis program in the publication "100 Bankable Post Harvest Equipment". It can also be used to develop data bases on:

   Sources and availability of materials and components.

   Inventory of manufacturers and their capabilities and manufacturer's associations.

   List of manufacturing association members and their capabilities.

   Data bases for economic and socio-economic analysis.

   Cad/cam systems (low cost software now available).

   Desk Top preparation of training materials and reports combining text and graphic material (low cost software becoming available).

   The computers are compatible in that each can run the same software and files can be transferred between all computers at each Center and any other IBM compatible MS?DOS computer system. Substantial public domain software is available and useful software is being developed rapidly in India.

4. Prototype modification workshop : Machine tools and spares will be provided to perform simple modifications in design materials as the manufacturers prototypes are being developed. Some tools and equipment may serve multipurposes during the manufacturing, modification and training operations.

5. Field evaluation : A minimum of one hectare of land will be available for evaluating and operating commercial prototypes before farmer field tests and demonstrations. The machines should be evaluated for performance, durability and ease of operation. The field evaluation area will also be used during training courses being conducted at the centre. Irrigation and drainage equipment will be installed to provide soil water management practices.

6. Classroom: A minimum of one classroom will be made available for lecture training of participants to the centre training programmes.

7. Laboratory Training: Equipment and facilities will be provided to accommodate approximately 20 participants. Some tools and equipment must be purchased in multiple quantities to accommodate proper training practices.

8. Conference room: Appropriate space will be provided for small conferences, 25 persons. The facility will be equipped with appropriate tables, chairs and audio-visual equipment for oral presentations.

9. Information accumulation and dissemination: As machines are developed for manufacturing and promotion, relevant publications and materials will be developed to distribute among interested parties. Operators manuals, field evaluation reports and information relative to materials and manufacturers will be available.

10 Storage: An area for storing parts, supplies and materials used for operating the centre that will protect the items from inclimate weather and provide security from theft.

11 Vehicles: The activities of the project will require a great deal of mobility on the part of the Centre staff.
The large demonstration van will be utilized to demonstrate to manufacturers and farmers in the various states assigned to each center. The body will be custom built on a long, 7 ton truck chassis. The front cab needs to accomodate the demonstration scientist, a craftsman, a manufacturer's representative and the driver/equipment operator. There can be limited sleeping space in the front of the van. The rear portion should be an enclosed van area with storage racks for tools and repair equipment and space for several items of equipment to be demonstrated. It is suggested the design of the vans be similar to the vans being used by VST Tillers manufacturing company in Bangalore.

The small demonstration van will be utilized to conduct field trials, evaluations and demonstrations of equipment in farmer's fields near the Centres. The small van will have a medium length 3 ton chassis with a 16 foot enclosed body.

One jeep each for the Bhopal, Coimbatore and Ludhiana Centres will be needed for general transport of personnel, acquire supplies and materials and be used as a liaison vehicle to testing/demonstration sites. It should have a trailer hitch so a trailer can be used when large quantities of materials or equipment need to be transported. An ambassador car will be purchased for the use by consultants, the Project Director and members of the coordinating cell located at Bhopal and to transport officials visiting the project.

EQUIPMENT

The following equipment list will be provided for each of the three centres:

ITEM	COST (Rs)
A. Drawing and Drafting Equipment	
1. Continuous blue printing machine	50,000
2. Paper trimmer with safety line	2,000
3. Drawing cabinet	4,000
Sub total	56,000
B. Material Testing Equipment and Facilities	
1. Hardness tester, Brinell Digital	50,000
2. Dynamic balancing machine	50,000
3. Air conditioner for laboratory	50,000
4. Strobotac	50,000
Sub total	2,00,000
C. Workshop Equipment and Machines	
1. Hydraulic press	1,00,000
2. Pneumatic hammer	80,000
3. Power bending machine	15,000
4. Universal shearing and punching machine	2,50,000
5. Spot welding machine (3 mm thickness)	10,000
6. Arc welding sets (4)	40,000
7. Gas profile cutting machine	40,000
8. Cylindrical grinding machine	80,000
9. Universal milling machine	1,50,000
10. Surface grinder	50,000
11. Portable electric sheet metal shear (hand)	2,000
12. Band saw	50,000
13. Pillar drilling machine	30,000
14. Pedestal grinder	5,000
15. Power hack saw	4,000
16. Abrasive cutter	3,000
17. Heat treatment and foundry equipment	2,00,000
18. Forging hammer and accessories	50,000
19. Wood working equipment	50,000
20. Universal working machine	50,000
21. Circular saw	10,000
22. Wood working lathe (copying)	25,000
23. Power sander	2,000
24. Thickness planer (450 mm wide x 225 mm thick)	15,000
25. Portable electric generator (3)	1,00,000
26. Inert gas welder	50,000
27. Paint spray gun	2,000
28. Motorized pipe bending machine	70,000
29. Flexible shaft grinder	7,000

30.	Engraving machine	10,000
31.	Hot stamping machine	2,000
32.	Vertical motorized injection moulding machine	50,000
33.	Motorized guillotine shears over drive/geared	1,50,000
34.	Precision bench shear	7,000
35.	Notching machine	3,000
36.	Universal sheet worker	50,000
37.	Universal swaging and beading machine	5,000
38.	Circle cutting machine	30,000
39.	Bending rollers	1,50,000
40.	Universal edging and folding machine	50,000
41.	Tapping machine	5,000
42.	Slotting machine	30,000
43.	Planing machine	1,50,000
44.	Shaping machine	1,50,000
45.	Band saw blade brazing machine	5,000
46.	Screw press	20,000
47.	Air compressor	30,000
48.	Portable electric drill.(4)	10,000
49.	Radial drilling machine	2,00,000
50.	Gantry for material handling	15,000
51.	Measuring instruments and hand tools	1,00,000
	Sub total	27,62,000

D. Tool Production and Fabrication Facilities

1.	Central Lathe machine (1000 mm centre to centre x 420 mm swing over bed)	2,30,000
2.	Universal milling machine (longitudinal feed 550 mm x crossfeed 180 mm x vest 400 mm)	2,00,000
3.	Double ended grinder (2)	10,000
4.	Precision tools and accessories	1,25,000
5.	C.I. surface plate	15,000
6.	Tool and Cutter Grinder	1,00,000
	Sub total	6,80,000

E. Office Equipment

1.	Tables (8)	16,000
2.	Chairs (60)	40,000
3.	Manual typewriters (2)	20,000
5.	Xeroxing machine	50,000
6.	Audio-video equipment,(TV, automatic slide projector)	20,000
7.	Computer	
	XT, desk top	31,000
	PC, desk top	20,000
	Dot Matrix printer	9,000
	Letter quality printer	15,000
	XY plotter	20,000
	Related software	5,000
8.	Regulated power supply (2)	4,000
	Sub total	2,50,000

F. Vehicles

1.	Diesel jeep	1,50,000
2.	Demonstration Van, 10 ton chassis	2,50,000
3.	Demonstration Van/Mini bus, 3 ton chassis	2,00,000
	Sub-total	6,00,000

G. Prime Movers & Engines

1.	Four wheel Tractor	1,25,000
2.	Power Tiller	40,000
3.	Diesel Engines/power units (2)	20,000
	Sub-total	1,85,000

H. Expendable Equipment and Supplies

Only indigenous office, shop, field and laboratory equipment and supplies will be used

1.	Materials replacement revolving fund	1,00,000
2.	Prototype equipment revolving fund	1,00,000
	sub-total	2,00,000

I. The following equipment will be located only at CIAE, Bhopal (Cooperating Center):

1.	Chemical and mechanical/metallurgical testing laboratory equipment	1,20,000
2.	Programmable die cutting machine	3,00,000
3.	Programmable lathe	5,00,000
4.	Heat treatment unit (electric or furnace, induction case hardening, normalizing, quenching-oil & salt, nitriding, cyaniding, carbonizing)	20,000
	Sub-total	9,40,000

J. Euipment for Coordination Cell

1.	Electronic typewriter	30,000
2.	Manual typewriter	10,000
3.	Duplicating machine with stencil storage facility	20,000
4.	Automatic stencil cutter	50,000
6.	Blue printing machine	50,000
7.	Paper trimmer with stapler & safety line	2,000
8.	Display boards with stands (20)	20,000
9.	Furniture for staff (tables, chairs, bookcases, almirahs, filing cabinets)	60,000
10.	Xeroxing machine	50,000
11.	Audio visual equipment (TV, overhead Projector & Silde projector with screen)	30,000
12.	Committee room furniture & furnishing	1,75,000
13.	Computer PC/XT with word processor and NLQ printer facility	75,000
14.	Car	1,50,000
	Sub-total	7,38,000

Total for the Cooperating Center at CIAE (A+B+C+D+E+F+G+H+I) 58,73,000

Total for the Cooperating Center at PAU (A+B+C+D+E+F+G+H) 49,33,000

Total for the Cooperating Center TNAU (A+B+C+D+E+F+G+H) 49,33,000

Total for the Coordinating Cell (J) 7,38,000

Grand Total 1,64,77,000

IMPORTED

		(US $)
A.	Precision Machines, Testing Instruments and Equipment	
1.	Sound measuring equipment	1,000
2.	Electronic balance	8,000
3.	Recorder with multiple speeds, 6 channel	10,000
4.	Strain gauge dynamometers for bullock implements	3,000
5.	Strain gauge transducers for measuring force, Torque, pressure and vibration.....	10,000
6.	Assortment of strain gauges	2,000
7.	Single lens reflex 35 mm camera with wide angle and telephoto lens	700
8.	Video equipment, VHS, VCR with editing capability, Camera,.....	5,000
	Sub Total.....	39,700
B.	The following equipment would be located only at CIAE Center	
1.	Universal Testing Machine (Instrou).....	15,000
	Sub Total.....	15,000
	Total for Cooperating Center at CIAE.....	54,700
	Total for Cooperating Center at PAU.....	39,700
	Total for Cooperating Center at TNAU.....	39,700
	Grand Total	134,100

F. SUMMARY

	Rs.	$
I. (a) Consultancy (US)		
- Lead consultant (2 months each for four years @ $15,000/mm)	-	120,000
- Professional consultants (10 weeks each for 3 years @ $15,000/mm)	-	112,500
Sub Total	-	232,500
(b) Consultancy (India)		
- Professional consultants (10 weeks each for 3 years @ Rs. 18000/mm)	135,000	-
Sub Total	135,000	-
II. (a) Study Tours		
- Management Team (9 members for total of 7.5 mm @ $7,000/mm)	-	52,500
- Industry representatives one each from USA to India and India to USA every year (total 8 visits of 3 weeks each @ $6,000/visit)	-	48,000
- ASAE representative to ASAE Conference during Ist, 3rd & 5th Years for 15 days each @ $5,500/visit	-	16,500
- ASAE representative to ISAE convention during Ist, 3rd & 5th Years for 15 days each @ $5,500/visit	-	16,500
Sub Total	-	133,500
III. (a) Trainings in USA		
- Sub project staff 9 Nos. for 4 months each @ $7,000/trainee	-	63,000
Sub Total	-	63,000
(b) - Training in India		
- Sub project staff		
- Travel within India	53,000	-
- DSA (Standard Govt. rate)	55,000	-
- Arrangements for training (@ Rs. 12,000/training for 11 trainings)	132,000	-
Sub Total	240,000	-
- Manufacturers (6 @ Rs.60,000 ea)	360,000	-
- Farmers (15 @ Rs.60,000 ea)	900,000	-
- Government staff, bankers (6 @ Rs.25,000 ea)	150,000	-
Sub Total	1,410,000	-

		Rs.	$
IV.	EQUIPMENT		
	- Drawing and Drafting	168,000	-
	- Material testing	600,000	-
	- Workshop	9,226,000	134,100
	- Tool Production & Fabrication	2,040,000	-
	- Office	1,338,000	-
	- Expendable	600,000	-
	Sub Total	13,972,000	134,100
V.	Vehicles and Prime movers	2,505,000	-
VI.	Building (Remodelling/extension of existing structure)	3,500,000	-
VII.	Maintenance of equipment, vehicles, building and supplies etc.	6,231,000	-
VIII.	Staff - salaries and perks	18,311,000	-
	- in-country travel	1,010,000	-
	Sub Total	19,321,000	-
IX.	Workshops, Symposia and conferences	425,000	-
X.	Documentation and Publications	780,000	-
XI.	Promotion of Manufacturers' Association	200,000	-
XII.	Seminar (Inter-state Trade of Farm Equipment)	200,000	-
	Total	48,919,000	563,100

COST ESTIMATES - INDO/US SUBPROJECT ON FARM EQUIPMENT MANUFACTURING CENTRE (CIAE BHOPAL) COORDINATING CELL

(Rs. in Lakhs)

Sl. No.	Post	Grade	Pay Scale Un-revised/	Pay Scale Revised (Rs.)	Years I	II	III	IV	V	Total
I.	PAY AND ALLOWANCES									
1.	Project Director (FMP)	S-4	1800-2250	4500-150-5700	0.387	0.773	0.792	0.811	0.830	3.583
2.	Engineer Techno-Economic Feasibility (Engineer/ Business Management/Economics (1)	S-3	1500-2000	3700-125-4700-150-5000	0.327	0.671	0.687	0.703	0.722	3.110
3.	Senior Engineer Training (1)	S-3	1500-2000	-do-	0.327	0.671	0.687	0.703	0.722	3.110
4.	Senior Engineer (Industrial Liaison) (1)	S-3	1500-2000	-do-	0.327	0.671	0.687	0.703	0.722	3.110
5.	Sr. Draftsman-cum-Artist (1)	T-6	700-1300	2200-75-2800-100-4000	0.241	0.496	0.509	0.522	0.526	2.294
6.	Stenographer		425-700	1400-40-1800-50-2300	0.151	0.309	0.316	0.322	0.329	1.427
7.	Junior Stenographer (1)		330-560	1200-30-1560-40-2040	0.136	0.278	0.283	0.288	0.293	1.278
8.	Junior Clerk (1)		260-400	950-20-1150-25-1500	0.096	0.196	0.199	0.203	0.206	0.900
9.	Driver (1)		260-430	975-25-1150-30-1540	0.099	0.203	0.206	0.210	0.214	0.932
10.	Helper/Messenger (2)		196-232	750-12-870-14-940	0.131	0.264	0.268	0.272	0.274	1.209
				Sub-Total (Salaries)	2.212	4.532	4.634	4.737	4.838	20.953
	LTC, Medical facilities and other perks etc. @ 5% of salary				0.111	0.226	0.232	0.236	0.242	1.047
				Sub-Total (Pay & Allowances)	2.323	4.758	4.866	4.973	5.080	22.000
II.	TRAVELLING ALLOWANCE				0.300	0.500	0.600	0.600	0.600	2.600
III.	RECURRING CONTINGENCIES				0.240	0.480	0.480	0.480	0.480	2.160
IV.	NON-RECURRING CONTINGENCIES									
	- Equipment				1.250	3.000	0.730	0.500	0.400	5.880
	- Vehicles				1.500	-	-	-		1.500
	- Works (remodelling/extension of existing structures)				2.000	3.000	-	-	-	5.000
				Sub-Total	4.750	6.000	0.730	0.500	0.400	12.380
V.	Workships, Conferences & Symposia				0.250	0.750	2.250	0.250	0.750	4.250
VI.	Documentation/Publications				0.500	1.000	1.000	1.000	1.000	4.500
VII.	Local Consultants (10 man-months @ Rs. 12,000/man-month)				-	0.450	0.450	0.450	-	1.350
				GRAND TOTAL (COORDINATION CELL)	8.363	13.938	10.376	8.253	8.310	49.240

COST ESTIMATES - INDO/US SUBPROJECT ON FARM EQUIPMENT MANUFACTURING CENTRE (CIAE BHOPAL) COOPERATING CENTRE

(Rs. in Lakhs)

S. No.	Post	Grade	Pay Scale Un-revised/	Pay Scale Revised (Rs.)	Years I	II	III	IV	V	Total
IV	AND ALLOWANCES									
1.	Sr. Agriculture Engineer (1)	S-3	1500-2000	3700-125-4700-150-5000	0.327	0.671	0.687	0.703	0.722	3.110
2.	Sr. Production Engineer (1)	T-8	1300-1700	3000-100-3500-1250-5000	0.291	0.598	0.614	0.630	0.646	2.779
3.	Agriculture Engineer (1)	S-2	1100-1600	3000-100-3500-125-4500	0.291	0.598	0.614	0.630	0.646	2.779
4.	Fore-man (1)	T-7	1100-1600	3000-100-3500-125-4500	0.291	0.598	0.614	0.630	0.646	2.779
5.	Asst. Production Engineer (1)	S-1/T-6	700-1300	2200- 75-2800-100-4000	0.241	0.496	0.509	0.522	0.526	2.294
6.	Asst. Training and Demonstration Engineer (1)	S-1/T06	700-1300	2200- 75-2800-100-4000	0.241	0.496	0.509	0.522	0.526	2.294
7.	Training and Demonstration Assistant (2)	T-4	550- 900	1640- 60-2600-75-2900	0.360	0.738	0.754	0.768	0.790	3.410
8.	Draftsman (1)	T-4	550-900	1640- 60-2600- 75-2900	0.180	0.369	0.377	0.384	0.395	1.705
9.	Senior Technician (4)	T-1-3	425-700	1400- 40-1800- 50-2300	0.606	1.236	1.264	1.288	1.316	5.710
10.	Tracer (1)	T-2	330-560	1200- 30-1560- 40-2040	0.136	0.278	0.283	0.288	0.293	1.278
11.	Craftsman (12)	T-1	260-430	975- 25-1150- 30-1540	1.194	2.436	2.472	2.520	2.568	11.190
12.	Driver (3)	SS-1	260-400	950- 20-1150- 25-1500	2.895	0.588	0.597	0.609	0.618	5.307
	Helper (6)	SSG	196-232	750- 12- 870- 14- 940	0.393	0.792	0.804	0.816	0.822	3.627
	J. Stenographer (1)		330-560	1200- 30-1560- 40-2040	0.136	0.278	0.283	0.288	0.293	1.278
	Accounting Clerk (1)		330-560	1200- 30-1560- 40-2040	0.136	0.278	0.283	0.288	0.293	1.278
13.	Jr. Clerk (1)		260-400	950- 20-1150- 25-1500	0.096	0.196	0.199	0.203	0.206	0.900
14.	Messenger (1)		196-232	750- 12- 870-140- 940	0.065	0.132	0.134	0.136	0.137	0.604
15.	Store Attendant (1)		196-232	-do-	0.065	0.132	0.134	0.136	0.137	0.604
16.	Safaiwala (1)		196-232	-do-	0.065	0.132	-.134	0.136	0.137	0.604
					8.009	11.042	11.265	11.497	11.717	53.530
	I.TC, Meical facilities and other perks etc. @5% of salary				0.400	0.552	0.563	0.574	0.585	2.674
			Sub-Total -1		8.409	11.594	11.828	12.071	12.302	56.204

(Rs. in Lakhs)

Sl. No.	Post	Grade	Pay Scale Un-revised/ Revised (Rs.)	Years I	II	III	IV	V	Total
I.	PAY AND ALLOWANCES			8.409	11.594	11.828	12.071	12.302	56.204
II.	TRAVELLING ALLOWANCES			0.300	0.500	0.500	0.600	0.600	2.500
III.	RECURRING CONTINGENCIES								
	R&D Contingencies			0.300	0.600	0.600	0.600	0.600	2.700
	Installation and Maintenance of workshop equipment			1.500	1.500	0.750	0.750	0.500	5.000
	POL for vehicles			0.250	0.500	0.500	0.500	0.500	2.250
	Repairs & Maintenance of vehicles @ 10% of initial cost per year			0.350	0.650	0.650	0.650	0.650	2.950
	Maintenance of Building			0.200	0.500	0.500	0.500	0.500	2.200
	Electricity charges			0.300	0.600	0.600	0.600	0.600	2.700
	Packaging, forwarding and contractual services			0.250	0.500	0.500	0.500	0.500	2.250
	Sub-Total III			3.150	4.850	4.100	4.100	3.850	20.050
IV.	NON-RECURRING CONTINGENCIES								
	Equipment*			20.000	25.000	3.000	2.000	0.880	50.880
	Vehicles and Prime movers			4.600	3.250	-	-	-	7.850
	Works (remodelling/extension of existing structures)			10.000	-	-	-	-	10.000
	Sub-Total IV			34.600	28.250	3.000	2.000	0.880	68.730
V.	TRAINING IN INDIA								
	- Subproject Staff			0.500	0.300	-	-	-	0.800
	- Manufacturers/farmers etc.			0.500	1.050	1.050	1.050	1.050	4.700
	Sub-Total V			1.000	1.350	1.050	1.050	1.050	5.500
VI.	Documentation /Publication			0.100	0.250	0.250	0.250	0.250	1.100
	GRAND TOTAL (CIAE CENTRE)			47.559	46.794	20.728	20.071	18.932	154.084

Excluding imported equipment worth $54,700

COST ESTIMATES - INDO/US SUBPROJECT ON FARM EQUIPMENT MANUFACTURING TECHNOLOGY CENTRES
(PAU- LUDHIANA & TNAU- COIMBATORE)

(Rs. in lakhs)

SUB-HEAD				YEAR					
PAY AND ALLOWANCES									
Designation	Grade	Pay Scale Pre-revised/	Pay Scale Revised (in Rs.)	I	II	III	IV	V	Total
Sr. Agril. Engineer (1)	S-3	1500-2000	3700-125-4700-150-5000	0.327	0.655	0.671	0.687	0.703	3.043
Agriculture Engineer (1)	S-2	1100-1600	3000-100-3500-125-4500	0.291	0.582	0.598	0.614	0.630	2.715
Sr. Production Engineer (1)	T-8	1300-1700	3000-100-3500-105-5000	0.291	0.582	0.598	0.614	0.630	2.715
Asst. Production Engineer (1)	S-1/T-6	700-1300	2200- 75-2800-100-4000	0.242	0.483	0.496	0.509	0.522	2.252
Asst. Training and Demonstration Engineer (1)	S-1/T-6	700-1300	2200- 75 2800-100-4000	0.242	0.483	0.496	0.509	0.522	2.252
Training and Demonstration Assistant (2)	T-4	550-900	1640- 60-2600- 75-2900	0.361	0.722	0.738	0.754	0.768	3.343
Foreman (1)	T-7	1100-1600	3000-100-3500-125-4500	0.291	0.582	0.598	0.614	0.630	2.715
Senior Technician (4)	T-1-3	425-700	1400- 40-1800- 50-2900	0.606	1.212	1.236	1.264	1.288	5.606
Draftsman (1)	T-4	550-900	1640- 60-2600- 75-2900	0.180	0.361	0.369	0.377	0.384	1.671
Tracer (1)	T-2	330-560	1200- 30-1560- 40-2040	0.136	0.272	0.278	0.283	0.288	1.257
Craftsman (12)	T-1	260-430	975- 25-1150- 30-1540	1.194	2.388	2.436	2.472	2.520	11.010
Helpers (6)	G	196-232	750- 12- 870- 14- 940	0.393	0.786	0.792	0.744	0.816	3.531
Drivers (3)	SS-1	260-400	950- 20-1150- 25-1500	0.288	0.579	0.588	0.597	0.609	2.661
Junior Stenographer (1)		330-560	1200- 30-1560- 40-2040	0.131	0.272	0.278	0.283	0.288	1.252
Junior Clerk (1)		260-400	950- 20-1150- 25-1500	0.096	0.193	0.196	0.199	0.203	0.887
Accounting Clerk (1)		330-560	1200- 30-1560- 40-2040	0.131	0.272	0.278	0.283	0.288	1.252
Messenger (1)		196-232	750- 12- 870- 14- 940	0.065	0.131	0.132	0.134	0.136	0.598
Store Attende (1)		196-232	750- 12- 870- 14- 940	0.065	0.131	0.132	0.134	0.136	0.598
Safaiwala (1)		196-232	750- 12- 870- 14- 940	0.065	0.131	0.132	0.134	0.136	0.598
Sub-Total (salary)				5.395	10.817	11.042	11.205	11.497	49.956
Medical facilities and other perks etc. @ 5% of salary				0.270	0.540	0.552	0.560	0.575	2.497
Sub-Total (I)				5.665	11.357	11.594	11.765	12.072	52.453

(Rs. in lakhs)

Sl. No.	Designation	Grade	Pay Scale Pre-revised/ Revised (in Rs.)	YEAR I	II	III	IV	V	Total
I.	PAY AND ALLOWANCES			5.665	11.357	11.594	11.765	12.072	52.453
II.	TRAVELLING ALLOWANCES			0.300	0.500	0.500	0.600	0.600	2.500
III.	RECURRING CONTINGENCIES								
	R&D Contingencies			0.300	0.600	0.600	0.600	0.600	2.700
	Installation & Maintenance of workshop equipment			1.500	1.500	0.750	0.750	0.500	5.000
	POL for vehicles			0.250	0.500	0.500	0.500	0.500	2.250
	Repairs & Maintenance of vehicles (@ 10% of initial cost per year)			0.350	0.650	0.650	0.650	0.650	2.950
	Maintenance of Buildings			0.200	0.500	0.500	0.500	0.500	2.200
	Electricity charges			0.300	0.600	0.600	0.600	0.600	2.700
	Packing, forwarding & contractual services			0.250	0.500	0.500	0.500	0.500	2.250
	Sub-Total - III			3.150	4.850	4.100	4.100	3.850	20.050
IV.	NON-RECURRING CONTINGENCIES								
	Equipment*			20.000	15.500	3.000	2.000	0.980	41.480
	Vehicles			4.600	3.250	-	-	-	7.850
	Works(remodelling/extension or existing structures)			10.000	-	-	-	-	10.000
	Sub-Total			34.600	18.750	3.000	2.000	0.980	59.330
V.	TRAINING IN INDIA								
	Subproject staff			0.500	0.300	-	-	-	0.800
	Manufacturers/Farmers etc.			0.500	1.050	1.050	1.050	1.050	4.700
				1.000	1.350	1.050	1.050	1.050	5.500
VI.	DOCUMENTATION/PUBLICATIONS			0.100	0.250	0.250	0.250	0.250	1.100
	Grand Total (for one centre)			44.815	37.057	20.494	19.765	18.802	140.933

Total for 2 centres (PAU & TNAU) = Rs. 140.993 x 2 = Rs. 281.866 lakhs

Excluding imported equipment worth $ 39,700

SUMMARY OF COST ESTIMATES - RUPEE AND DOLLAR COMPONENTS

(In Lakhs)

Sl. No.	Item	Year I Rs.	Year I $	Year II Rs.	Year II $	Year III Rs.	Year III $	Year IV Rs.	Year IV $	Year V Rs.	Year V $	Total Rs.	Total $
1.	Consultancy												
	- U.S.	-	-	-	0.675	-	0.675	-	0.675	-	0.300	-	2.325
	- Indian	-	-	0.450	-	0.450	-	0.450	-	-	-	1.350	-
2.	Study Tours	-	0.635	-	0.120	-	0.230	-	0.120	-	0.230	-	1.335
3.	Training												
	- In U.S.A.	-	0.210	-	0.210	-	0.210	-	-	-	-	-	0.630
	- In India	3.000	-	4.050	-	3.150	-	3.150	-	3.150	-	16.500	-
4.	Equipment												
	- Imported	-	0.440	-	0.901	-	-	-	-	-	-	-	1.341
	- Indigenous	61.250	-	59.000	-	9.730	-	6.500	-	3.240	-	139.720	-
5.	Vehicles & Prime Movers	15.300	-	9.750	-	-	-	-	-	-	-	25.050	-
6.	Building Remodelling	32.000	-	3.000	-	-	-	-	-	-	-	35.000	-
7.	Maintenance of Facilities, equipment, vehicles & supplies	9.690	-	15.030	-	12.780	-	12.780	-	12.030	-	62.310	-
8.	Staff												
	- Salaries & Perks	22.062	-	39.066	-	39.882	-	40.574	-	41.526	-	183.110	-
	- In-country travel	1.200	-	2.000	-	2.100	-	2.400	-	2.400	-	10.100	-
9.	Workshops, Conferences and Symposia	0.250	-	0.750	-	2.250	-	0.250	-	0.750	-	4.250	-
10.	Documentation & Publications	0.800	-	1.750	-	1.750	-	1.750	-	1.750	-	7.800	-
11.	Promotion of Manufacturers' Association	-	-	0.500	-	0.500	-	0.500	-	0.500	-	2.000	-
12.	Seminar-cum-Workshop on Inter-State Trade of Farm Equipment	-	-	0.500	-	0.500	-	0.500	-	0.500	-	2.000	-
	Total	145.552	1.285	135.846	1.906	73.092	1.115	68.854	0.795	65.846	0.530	489.190	5.631

Total Sub-Project cost = Rs. 489.190 Lakhs
Rs.+ 76.018 Lakhs (equivalent of US$ 5.631 Lakhs @ Rs. 13.50 = 1 US $)
Rs. 565.208 Lakhs

Cost Estimates - Indo-US Sub-Project on Farm Equipment Manufacturing Technology Centres - US$ Component

Sl. No.	Sub-head	Year I	II	III	IV	V	Total
I.	CONSULTANCY						
	- Lead Consultant 8 mm $ 15,000/mm	-	30,000	30,000	30,000	30,000	1,20,000
	- Professional Consultants 3 for 10 weeks each @ $ 15,000/mm	-	37,500	37,500	37,500	-	1,12,500
	SUB TOTAL	-	67,500	67,500	67,500	30,000	2,32,500
II.	STUDY TOURS						
	- Management Team 9 members total 7.5 mm @ $ 7,000/mm	52,500	-	-	-	-	52,500
	- Industry Representatives one each every year for 3 weeks from India to USA and vice versa @ $ 6,000 per visit (8 visits)	-	12,000	12,000	12,000	12,000	48,000
	- One ISAE representative to ASAE Conference for 15 days during 1st, 3rd & 5th years (1.5mm)	5,500	-	5,500	-	5,500	16,500
	- One ASAE representative to ISAE Conference for 15 days during 1st, 3rs & 5th years(1,5mm)	5,500	-	5,500	-	5,500	16,500
	SUB TOTAL	63,500	12,000	23,000	12,000	23,000	1,33,500
III.	TRAINING IN USA						
	- Sub project staff 9 Nos. for 4 months each (total 36 mm) @ $ 7,000 per training	21,000	21,000	21,000	-	-	63,000
IV.	EQUIPMENT	44,000	90,100	-	-	-	1,34,100
	TOTAL	1,28,500	1,90,600	1,11,500	79,500	53,000	5,63,100

G. Principal Reports, Reviews and Evaluation

1. Reports:
   a. Monthly summary reports from each centre to the project director who will consolidate a total report to CIAE and ICAR.
   b. Quarterly activity report will be produced from each centre to CIAE and ICAR.
   c. Annual comprehensive report will be produced from each centre to the project director who will consolidate a comprehensive report to CIAE, ICAR and USAID.
   d. A comprehensive termination report will be prepared by the Project Director.

2. Reviews:
   a. The Coordination Committee will review project activities and develop future strategy annually.
   b. There will be a Machinery development review by the Advisory Committee annually
   c. There will be a mid-project review of the activities and developments by a panel of national and international experts selected by ICAR and USAID.
   d. There will be a final project review six months before the termination date by a panel of national and international experts selected by ICAR and USAID.

3. Evaluations:
   The project activities will be continuously monitored and evaluated by the Cordination Committee, the Advisory Committee and the Coordinating Cell. The project director may have a formal evaluation of any Centre or activity as necessary.

H. End of Subproject Status

1. New machines which raise farm production will be in use in large numbers in additional areas of India.

2. Quality of functional performance and durability of new machines will be increased while cost is reduced.

3. Farmers will get more benefit from machine usage by being better trained in operation, adjustment, maintenance and repairs.

4. Extension workers will have experience in giving effective demonstrations and realize that new machines can be introduced.

5. New and previous manufacturers will strive to sell quality machines. They will have the know-how and the tooling to produce them.

6. Centre staff will have experience and be skilled in the further development for production of new machines obtained from manufacturers or research engineers.

7. The Coordinating Committee and the Centre Advisory Committees will have experience and skills in selecting or planning the highest priority new machines for appropriate mechanization.

- APPENDIX -

Appendix A

FIELD TOUR OBSERVATIONS RELEVANT TO MECHANIZATION

In preparation for the development of the sub-project there were several field trips to gather information useful in the design project. A listing of the Major Manufacturers and Institutions visited is attached. These included State Agricultural Universities with emphasis on the agricultural engineering colleges and farm implement and machinery projects within these colleges. State Agro-Industry Corporations, state government officials, a variety of private sector manufaturers, farmers, villages, steel suppliers, other material suppliers, the Bureau of Indian Standards, the Indian Society of Agricultural Engineers, and the Central Institute of Agricultural Engineering at Bhopal were the major organizations contacted.

A wide range of activities were observed including productive efforts in both the public and private sectors and some instances where very little useful effort could be found. One of the dominant impressions was the great opportunity for establishing better communications between individuals and agencies responsible for stimulating the appropriate mechanization of Indian agriculture. In a number of instances the team was able to answer questions about activities or opportunities at other locations in India that was potentially useful to the group being visited and suggestions for follow up action were made on the spot. Some of the more important observations are briefly discussed.

Examples of Factors Leading to a Demand for Appropriate Mechanization

One of the most frequently mentioned driving forces creating a need for mechanization is the timeliness of operation. Throughout the country there are situations where critical jobs cannot be done with currently available labor. Changes in productivity factors such as the introduction of irrigation, fertilizer and high yielding varieties substantially increase the need for labor at critical times i.e. harvest and planting, the work cannot be done without mechanization. There is the example of the Punjab where these factors have lead to widescale use of tractors and grain threshers. This situation is becoming increasingly common in other areas. In West Bengal where increasing other inputs has resulted in a need to mechanize paddy harvesting and tillage so a potato crop can be planted on time. Timeliness of operations was also reported to be of great concern in some dryland areas visited.

Another situation is the one where changes in the local economy or in social circumstances contribute to a lack of labor for critical operations or the situation where it is economical to introduce new crops if and only if some mechanization is available to allow the work to be done on time. Also, the quality of the work is important and mechanization can result in increased total productivity. Several studies have shown fertilizer effectiveness can be increased 30% by use

of seed cum fertilizer drills and achieves better placement of seed and fertilizer compared to hand placement. In relatively dry conditions germination of sugar cane cuttings can be essentially doubled by mechanical planting due to the ability to retain more soil moisture near the cutting along with more accurate placement of fertilizer and pesticide. Another factor mentioned on seeding is the current generation of farm labor which is in general less skillful at seed placement than the preceding generation.

Subsidy for Farm Equipment

The question of subsidy for the puchase of farm machinery came up in many places. The GOI makes Rs 12 crore available to the states for subsidy to purchase qualified farm equipment and in general the states set up a program through the State Agro-Industry Corporation. In several places it was observed that the program is handled in such a way the small scale manufacturer is squeezed out as the only way the subsidy can be obtained by the farmer is through the state agro. This provides or can provide control over manufacturing by not allowing subsidy to equipiment manufactured by anyone other than the state agro. However, in other cases the state agro was working closely with local manufacturers both in production and marketing.

In a number of cases substantial business was being conducted in certain equipment lines without benefit of subsidy. Some manufaturers were able to sell quality equipment to farmers without subsidy more effectively than was being done through the public sector with subsidy. The explanation was that the equipment was cost effective and the hassle of getting the susidy was too difficult to bother with. This concept was also presented at a recent plastics conference with regard to purchase of drip irrigation systems for plantation crops without the allowable subsidy.

Economics

Several observations concerning the economics of mechanization follow:

Small land holdings are a great constraint to economic mechanization.

Custom hiring can often help mitigate the above factor.

Often the documented economic benefit of mechanization does not become credible until after substantial farmer experience.

Farmers frequently desire to purchase machines only on very short notice as per example when a large harvest is emminent and it becomes clear adequate labor is not going to be available

In view of the above a stockpile of equipment needs to be available and neither the farmer or the small manufacturer can carry the inventory cost and risk alone.

Inventory costs are constraints for a state agro, compounded by the tendency to receive cash flow to cover subsidy only at the end of the fiscal year.

Manufacturing Training

The subject of training was of great interest to a number of manufacturers and the concept of having manufacturers participate in the practical aspects of training for centre staff was well received. The desire to have access to training opportunities was widespread and included the topics of the use of jigs and fixtures, the use of standards and quality control features and improved manufacturing technology. There was also great interest in information on these topics and the activities of other manufacturers.

Information for Manufacturers

Many manufacturers expressed interest in access to information. Great interest was found in the possibility of having a ready scource of information on the availability of material, such as special quality steel and special parts such as bearings, gears and special fittings. There was almost universal interest in better information on marketing of machinery and knowledge of potential market areas.

Demonstration and Extension

The most frequent request from all categories of visits was for an improvement in the area of on farm demonstrations. It was pointed out over and over that on farm demonstrations are essential to learn about machine performance in a given area, to demonstrate to the farmer the quality of the performance and to thereby contribute to a demand for the machine. One company operates several demonstration vans throughout the country where company representatives travel with a sales agent in a given district giving intensive on farm demonstrations. Eighty percent of their promotion budget is earmarked for this actrivity. One state department has 13 demonstration vans performing a similar function and places high importance on this activity.

The second most common observation was of the need for agricultural engineering extension within the state agricultural department extension system. A number of people commented on the lack of agricultural engineers in extension and generally ascribed the cause to the domination of extension by crop production scientists. In most cases these conversations were with engineers. It was pointed out that in many cases agricultural advances have been due to good extension work in plant breeding, agronomic practices and pesticide use.

Manufacturers and other Associations

In Indore most of a local holiday was taken up with a meeting with the head of the state farm equipment manufacturers association. There had been a close interaction recently with the industrial Extension Division of CIAE in Bhopal and the state group. There is very strong interest in further strengthening this relationship and a strong and active manufacturers association can be helpful in improving the quality of agricultural tools and implements and in promoting their appropriate adoption. A number of manufacturers are expressing the feeling that improved quality of machinery both by themselves and their competition and efforts to generate farmer demand for products are important. It seems to be generally felt that increasing the market for products through these measures is more important to business than increasing their own market share at the expense of their competitors. Close association with and stimulation of state and local manufacturers associations could be helpful.

Privatization

The cornerstone of current efforts by the CIAE in Industrial Extension at Bhopal and Coimbatore is the stimulation of the small scale equipment manufacturer and the improvement in his ability to deliver a quality product. The manufacturers visited who are working with these groups constantly stressed their reliance of the quality of their own products to secure their success in the market. Their advertisements all stressed the quality of the product. There seems to be significant recognition of the need to follow up sales with service and spare parts. While there were strong steps taken in several of the state agros to control the private sector and to "protect the farmer from the manufacturer" by controlling the subsidy program, several other units were very anxious to use the local small scale manufacturers as sources of supply for implements they would sell and were working with the manufacturer to help improve quality and production. Thus the idea that the role of the state organization must be considered on a state by state basis is reinforced.

Standards

The major body in India for establishing standards im industry is the Bureau of Indian Standards. At the ISI headquarters there is a section on standards for agricultural equipment and a number of standards have been developed. Although there is no formal linkage with the Indian Society of Agricultural Engineers there is a close linkage as most of the standards committees have full representation of ISAE members and ISI has strong support of a number of leaders in the professional society. The Tractor Test Center at Budni is charged with testing and reporting results of testing tractors and pumps. ISI expressed interest and willingness to work closely with this project and potentially can play a key role in the projects ultimate success.

Other Notes

ICAR has established 90 farmer training centers and is working towards having one in each of the countries 495 districts.

The manufacturing facilities of two state agros visited were almost completely involved in the manufacture of products other than farm machinery or implements. These items were reported to be in demand and could be made from mild steel with simple manufacturing technology. Relatively sophisticated machine shop tools appeared to be by and large unused and rusting. These were the same organizations that appeared to avoid active marketing of implements made by and purchased from local manufacturers. In contrast, there seemed to be significantly greater activity in implement manufacturing by those state units encouraging production and making purchases from local private manufacturers.

A possible problem in some state organizations is the short tenure in office of the IAS officer in charge. Not only is an IAS not a technically oriented person but the average tenure in office of several visited appears to be about one year. In general the agricultural engineers encountered seemed to feel these factors were important. It was pointed out that while these state organizations were set up to provide farm equipment to the farmer as a key activity they had turned most of their efforts to sales of fertilizer, seeds and pesticides. A number of reasons were advanced for this situation which was generally considered as a problem. There was complete agreement that more needed to be done to bring appropriate mechanization more broadly into Indian agriculture and efforts to supplement whatever the states were currently doing.

Appendix B

B. PRACTICAL TRAINING OF THE SUBPROJECT STAFF AND MANUFACTURERS AT QUALITY LEADERS OF FARM MACHINERY MANUFACTURERS

Rationale

The object of this component is to catch the imagination of the subproject staff and selected manufacturing staff by taking one month training cum case studies at quality leaders in farm machinery manufacturing. These leaders have adopted quality in function and durability to capture a greater share of the market for their products in proven but very competitive markets. Having subproject staff and manufacturing staff taking training at the same time will not only save the host manufacturer's time and interruption but will encourage interaction between the two students. The subproject engineer can explain the engineering theory for many procedures while the person from industry can offer the practical side of manufacturing. The training should raise the aspirations of both groups by experiencing how quality is being achieved in the Indian farm machinery industry and why it improves sales for the manufacturer.

The overall objective of this component is to prepare the sub-project engineers to become respected trainers of small manufacturers in not only manufacturing technology but to have sufficiently broad understanding of industry to help them become viable quality manufacturers. To avoid burdening any single manufacturer with too many students, the training sites are spread around to several manufacturers with the higher staff being sent to the higher quality manufacturers. After all the training has been completed, all students from the subproject and industry should meet in seminars to discuss how various manufacturers approach quality. The initial manufacturers trained alongside the Subproject staff can be future sites for training other industry staff.

Matching of staff with manufacturers

The Project Director from Bhopal and a manufacturer from Punjab selected by PAU will study at VST Tillers, Bangalore.

The Project Engineers and manufacturers from Bhopal, Coimbatore, and Ludhiana will all train at American Spring and Pressing Works, Bombay.

The S-2 Agricultural Engineer, the T-8 Senior Production Engineer and a manufacturer outside the home state of the three centres will train at three manufacturers of the quality of Mekins in Hyderabad, Baheti in Indore, and Agricultural Disc Corporation in Karnal.

The other two engineers and the T-7 Foreman from each centre along with manufacturers outside the home states of the three centres should train at manufacturers outside their home state such as Martin Burn in Calcutta, Sigma Steel Industries in Ludhiana, Jyoti Ltd. in Vadodara, Cossul & Company in Kanpur, Beco Engineering in Batala, Light Carts Private Ltd. in Meerut, LCT in

Coimbatore, Union Forgings in Ludhiana, Standard Agricultural Engineering in Ludhiana, and similar quality manufacturers who make quality, repeatable parts by use of templates, fixures and gauges.

The two Draftsmen and four Senior Technicians may get on-the-job training of a more specialised nature in factories in the states of the centres which will upgrade their skills and vision for quality work.

Areas of Study

I. RESOURCES REQUIRED

A. Finances

1. Amount and source of original capital for land, buildings, and tooling
2. Amount and source of expansion capital for land, buildings, and tooling.
3. Amount and source of money for operation.

B. Staff

1. Management organisation
2. Education and experience of top 20% of staff
3. Pay scales and perks of office and production staff
4. Production labour used - permanent, casual, contract

C. Products

1. Products previously made and reason for dropping
2. Current products by type and size
3. Sales for each of last five years by type and size
4. Selection of new products
5. Design source of new products
6. Functional improvements made on products
7. Durability improvements made on products
8. Cost improvements made on products
9. Improvements made for different crops or geographic regions

D. Purchasing for production

1. Annual steel use by source, amount, and cost/kg

   a. Carbon content - M.S. and each other
   b. Surface finish - cold rolled, hot rolled, rerolled
   c. Shapes - sheets, rounds, rectangular bars, angles, channels, tees, etc.

2. Annual casting use by source, amount, cost/kg.
3. Use of other metals and plastic
4. Annual wood use by source, amount and cost/kg.
5. Standard parts - bolts, bearings, belts, chains, etc.
6. Special parts - reaper knife sections, drill fluted feeds, etc.
7. Percent of total purchases for each item above

II. MANUFACTURING

A. Plant layout and material flow

1. Receiving and storage of raw materials and parts
2. Cutting to length and shape
3. Machining
4. Cold bending and forming
5. Hot forging
6. Casting
7. Welding
8. Assembly
9. Painting
10. Shipping

B. Production equipment - Capacity sizes, Cost, Source city & Brand

1. Power hacksaws and shears for barstock
2. Sheet metal shears and punches
3. Drills, lathes, milling machines, shapers, etc.
4. Press brakes, folding brakes, rolls, form dies, etc.
5. Hot forge and hammer
6. Foundry equipment
7. Arc welders, spot welders, gas welders and cutting torches
8. Assembly tools
9. Painting equipment

C. Production Quality Control

1. Who is responsible for quality?
2. How is quality determined?
3. How are dimensions held for interchangeable parts?
4. How are templates made and used?
5. How are drill fixtures made and used?
6. How are weld fixtures made and used?
7. How are guages made and used?
8. What final inspection is given for drive trains?
9. What final inspection assures functional performance?

III. SALES AND SERVICE

A. Customer awareness of your product

1. Field demonstrations held annually by number and location
2. Displays at farmers fairs (Kisan Melas)
3. Extension help from the government
4. Other advertising and promotion

B. Sales organisation

1. Within factory
2. Dealer number and location

C. Annual Rs. Sales

1. Total
2. Direct to farmers without subsidiary
3. Direct to farmers with subsidiary
4. To or through government
5. By state
6. By district in home state
7. Share of market by product in home district
8. Total sales per employee

D. Retail prices to farmers

1. How are prices determined?
2. How do prices compare to competitors?
3. Range of product prices, Rs./kg.
4. What government subsidiaries are given for each product?
5. What credit sources are available at what interest rates?
6. How much custom hiring is done with each product?
7. What annual crop production is required to justify use on owners farm only?

E. Service and repairs

1. Are Operator's Manuals furnished covering operation, maintenance, and safety?
2. What warranty is given to customer?
3. Are repair parts interchangeable or must they be fit?
4. Where does farmer get most of his repair work done?
5. How much of your repair work is done in field and how much in factory?
6. What percentage of total business is in repair parts and service?

Appendix C

MANUFACTURING ORGANIZATIONS VISITED

	COMPANY NAME	LOCATION
1.	American Spring and Press Works	Bombay
2.	Anand Krishi Yantra Udyoug	Indore
3.	Andhra Pradesh State Agro-Industries Corp.	Hyderabad
4.	Aruna Implements and Farm Machinery	Hyderabad
5.	Baheti Agro-Products	Indore
6.	Bora Brothers Industries	Bhopal
7.	Dev Agro Tools Private Ltd.	Bangalore
8.	Fleet Manufacturing Co.	Bhopal
9.	HMT	New Delhi
10.	Implement Factory of Bhubaneshwar	Bhubaneshwar
11.	Karnataka State Agro-Industrial Corp.	Bangalore
12.	Karshak Farm Machinery and Implements	Hyderabad
13.	Kasim Manufacturing Co.	Kanpur
14.	Lakshmi Industry	Bhopal
15.	Lalwani Earthmovers	Bhopal
16.	Mekins Agro Products Pvt. Ltd.	Hyderabad
17.	Orissa Agricultural Implement Corp.	Bhubaneshwar
18.	Raghwnath Monapatra Co.	Bhubaneshwar
19.	Sarada Industries	Calcutta
20.	S. R. Engineering Works	Bangalore
21.	Swathi Industries	Coimbatore
22.	Tata Iron and Steel	New Delhi
23.	Uttar Pradesh State Agro-Industrial Corp.	Lucknow
24.	Vishwakarma Industries	Hyderabad
25.	V.S.T. Tillers	Bangalore
26.	Wallace Co.	Calcutta

INSTITUTIONS AND AGENCIES VISITED

	INSTITUTE NAME	LOCATION
1.	Agricultural Finance Corporation	Lucknow
2.	Andhra Pradesh Agricultural University	Hyderabad
3.	Bureau of Indian Standards	New Delhi
4.	Central Institute of Agricultural Engineering	Bhopal
5.	Indian Council For Agricultural Research	New Delhi
6.	Karnataka Agricultural University	Bangalore
7.	National Soybean Research Center	Indore
8.	Orissa Agricultural University	Bhubaneshwar
9.	Sugarcane Research Station	Lucknow
10.	Tamil Nadu Agricultural University	Coimbatore
11.	USAID-Winrock International	New Delhi
12.	U.S. Embassy Agricultural Counselor	New Delhi
13.	Uttar Pradesh Agricultural University	Kanpur
14.	Indian Society of Agricultural Engineers	New Delhi