

Long-term Strategies and Programmes for Mechanization of Agriculture in Agro Climatic Zone-VI : Trans-Gangetic Plains region

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1. NAME OF THE AGRO CLIMATIC ZONE : Trans-Gangetic Plains region
2. STATES UNDER THIS ZONE : Chandigarh, Delhi, Haryana, Punjab, Rajasthan (Ganganagar District)



3. SUB-AGRO CLIMATIC ZONES WITH THEIR CHARACTERIZATION

The Trans-Gangetic Plain Region encompasses areas included in the States of Punjab, Haryana, Plain region of Rajasthan as well as the Union Territories of Chandigarh and Delhi. The sub-zones cut across State boundaries. The climate is arid, semi-arid and sub-humid in different districts. In summer months temperatures rise up to 43°C radiating heat waves with occasional dust storms. Rainfall varies from 190 mm to 1,150 mm. The river Beas, Ravi, Sutlej, Yamuna and Ghaggar are important sources for irrigation in the zone. Agricultural Development in this region has witnessed a phenomenal increase in agricultural productivity ranging from 2 to 4 fold in most areas. This quantum jump in Agricultural Production and productivity in the aforesaid region is popularly known as Green Revolution.

3.1 Foot Hills of Shivalik

This is a relatively small sub-zone, covering the districts of Gurdaspur, Hoshiarpur and Rupnagar in Punjab and Ambala in Haryana. It also includes Chandigarh. The region receives about 1,000 mm rainfall and the climate is sub humid. Nearly 16% of the land is under forests and about 65% is cultivated. About 60% of the net sown area is irrigated. Three-fourths of the irrigation is through ground water resources.

3.2 Plains

This sub-zone, which is placed in the basin of the Indus and the Ganga, is bounded in the north by the Shivalik hills and in the east by the Yamuna river. The soil is almost entirely alluvial, particularly in the Punjab areas. The sub-zone includes the Amritsar, Kapurthala, Jalandhar, Ludhiana and Patiala districts of Punjab. In Haryana, the sub-zone runs over sand dunes. The districts from Haryana include Kurukshetra, Karnal, Jind, Sonapat, Rohtak, Faridabad and Gurgaon. The normal annual rainfall is 720 mm in the Haryana districts and 628 mm in the Punjab districts. The climate is semi-arid to dry and sub-humid and the soil is alluvial. Over 80% of the land is sown and over 80% of the sown area is irrigated.

3.3 Arid

The advent of the Indira Gandhi Canal and the new irrigation facilities available to the region, have transformed this region significantly. Over 80% of the land is available for cultivation. However, only about 70% of the net sown area is irrigated.

The sub-zone includes the districts of Mahendragarh, Bhiwani, Hisar and Sirsa in Haryana, Ferozpur, Faridkot, Bhatinda and Sangrur in Punjab and Ganganagar in Rajasthan.

4. GENERAL TOPOGRAPHY OF THE ZONE WITH BRIEF HISTORICAL BACKGROUND OF AGRICULTURAL DEVELOPMENT OF THE ZONE

The Trans-Gangetic Plain Region encompasses areas included in the States of Punjab, Haryana, Plain region of Rajasthan as well as the Union Territories of Chandigarh and Delhi. Agricultural Development in this region has witnessed a phenomenal increase in agricultural productivity ranging from 2 to 4 fold in most areas falling under this zone. This quantum jump in Agricultural Production and productivity in the aforesaid region is popularly known as Green Revolution. The areas falling under this zone have plain topography consisting of mainly medium and light soils. The region has high irrigation and cropping intensity. The region has highest fertilizer use (250 to 300 kg/ha) as compared to national average of about 100 kg/ha. The average yield of this region ranges from 4.4–5 tonnes/ha/year as against National average of about 1.2 tonnes/ha/year.

5. OPERATIONAL LAND HOLDING PATTERN BY MAJOR SIZE GROUP

The State-wise operational land holdings by major size groups are given in Table 1.

Table 1. State-wise Number of Operational holdings by major size groups (1995–96)*

Name of State/Union Territory						(in '000)
	Marginal	Small	Semi-medium	Medium	Large	Total
Punjab	204	183	320	306	80	1,093
Haryana	815	338	328	207	40	1,728
Rajasthan	1,611	1,085	1,117	1,064	487	5,364
Delhi	21	6	4	3	Neg.	35
Uttaranchal	N.A.	N.A.	N.A.	N.A.	N.A.	N.A.

Note: * - includes institutional holdings also; Neg. - Negligible; N.A. - Not Applicable

Source: Agricultural Statistics at a Glance 2004, Agricultural Statistics Division, Directorate of Economics and Statistics, Department of Agriculture and Cooperation, Ministry of Agriculture, Government of India.

Table 2. Distribution of population, sex ratio, density, % decadal growth rate—2001

	Total population			Sex ratio (females/ 1,000 males)	Density/km ²	% Decadal growth	
	Persons	Males	Females			1981–91	1991–01
Punjab	2,43,58,999	1,29,85,045	1,13,73,954	874	482	20.81	20.10
Chandigarh	9,00,635	5,06,938	3,93,697	773	7,903	42.16	40.28
Haryana	2,11,44,564	1,13,63,953	97,80,611	861	477	27.41	28.43
Delhi	1,38,50,507	76,07,234	62,43,273	821	9,294	51.45	47.02
Rajasthan	5,65,07,188	2,94,20,011	2,70,87,177	922	165	28.44	28.41
India	1,02,88,30,774	53,22,63,021	49,65,67,753	933	324	23.86	21.56

Source: Census of India, 2001, Series-1, Registrar General and Census Commissioner, New Delhi.

6. IMPORTANT SOIL TYPES

The major types of soils covered by this region are the deep loamy alluvium-derived soils with occasional saline and solaic phases as well as deep loamy to grey brown and deep loamy desert soils.

7. CLIMATE AND ANNUAL RAINFALL

The region has three distinct seasons, viz. Winter (November–March), Summer (April–June) and Rainy season (July–October). The rainfall occurs during the months of July–September with occasional showers during December–January. The average annual rainfall in this region varied between 312 and 650 mm during 2000. However, taking into account the past data, the rainfall varied from 190 and 1,150 mm.

8. POPULATION AND POPULATION DENSITY OF THE ZONE

Structure of the population in the region is given in Table 2.

9. BRIEF SCENARIO OF AGRICULTURE SECTOR

The crops grown in the areas covered by this region along with the cropped area, per cent irrigation and productivity are given in Table 3. It is quite evident that paddy-wheat rotation is the dominant crop rotation for Punjab and Haryana. Yield levels are the highest in Punjab followed by Haryana and Rajasthan. Different power sources, viz. human, animal and electro-mechanical are used by the farmers in this region. The dominant power sources, at present are the electro-mechanical sources. Availability of tractors and power tillers in the zone is given in Table 4 while farm power available by source is given in Table 5.

10. BRIEF SCENARIO OF ANIMAL HUSBANDRY SECTOR

The Animal Husbandry Sector in this region is well developed. Some of the best milch cattle are found in this region. Milk and egg production is indicated in the Table 6.

11. BRIEF SCENARIO OF FISHERIES SECTOR

State/Union Territory	Inland fish production (‘000 tonnes)
Punjab	20.0
Haryana	27.6
Rajasthan	9.2
Delhi	4.5
Chandigarh	0.7

12. IRRIGATED AREA AND SOURCE OF IRRIGATION

This area has the highest intensity of irrigation. In 1995–96, the percentage of irrigated area in Punjab was 93.7%, Haryana 78.6%, and Sriganagar district of Rajasthan about 95%. About 60% irrigation is by tubewells and 40% through canals.

13. INFRASTRUCTURAL FACILITIES AVAILABLE IN THE ZONE

(i) Metalled Roads

The region has excellent network of metalled roads.

(a) Metalled road connecting villages

State/Union Territory	Rural roads (km)
Punjab	38,953
Haryana	22,452
Rajasthan	63,064
Delhi	1,299
Chandigarh	76

Table 3. Important Crops of the Zone in 1996–97

State/Union Territory	Important crops	Area ('000 ha)	Irrigation (%)	Productivity (kg/ha)	
Punjab	<i>Field crops</i>				
	Cereals	6,046	97.09	3,780	
	Pulses	77.5	80.61	654	
	Oilseeds	176.4	64.44	1,193	
	Cotton	562	99.60	180*	
	Sugarcane	103	75.14	59,515	
	<i>Horticultural crops</i>				
	Fruits	90.295	–	899.9	
	Vegetables	120.135	–	1,360.5	
	Haryana	<i>Field crops</i>			
Cereals		4,063	83.23	2,897	
Pulses		427.1	26.08	827	
Oilseeds		558.3	70.54	1,279	
Cotton		582	99.23	*255	
<i>Horticultural crops</i>					
Fruits		23.878	–	737.6	
Vegetables		96.8	–	1,333	
Rajasthan		<i>Field crops</i>			
		Cereals	8,818.4	29.47	1,190
	Pulses	4,643.8	9.39	526	
	Oilseeds	4,303.3	59.67	886	
	Cotton	644.6	97.86	*230	
	Tobacco	2	50.0	–	
	<i>Horticultural crops</i>				
	Fruits	20.318	–	1,367.8	
	Vegetables	80.232	–	401.2	
	Delhi	<i>Field crops</i>			
Cereals					
Pulses		51.6	93.6	797	
Oilseeds		1.3	–	769	
Any other		4.8	93.6	14.6	
<i>Horticultural crops</i>					
Fruits		(a)	–	1,092.3	
Vegetables		83.798	–	392.7	
Chandigarh		<i>Field crops</i>			
		Cereals	1.4	–	
	Pulses	(a)	–		
	Oilseeds	–	–		
	Any other	–	–		
	<i>Horticultural crops</i>				
	Fruits	(a)	–	2,266	
	Vegetables	(a)	–	2,500	

Note: *, Thousand Bales of 170 kg each; (a), Area less than 1,000 ha.

Source: Fertilizer Statistics (1999–2000), The Fertilizer Association of India, New Delhi.

Table 4. Availability of Tractors and Power Tillers in Various Areas of Trans-Gangetic Plain region, 1997

State	Agriculture land ('000 ha)	Tractor		Power tiller	
		Population	Units/'000 ha	Population	Units/'000 ha
Punjab	4,033	3,32,700	82.5	20	0.0
Haryana	3,711	2,33,400	62.9	20	0.0
Rajasthan	20,971	1,75,300	8.4	30	0.0
India	1,65,509	20,15,600	12.2	65,930	0.4

Table 5. Farm Power Available by Source for Trans-Gangetic Plain region, 1995–96

State	Available power (kW/ha)				Per cent share in available power		
	Ani-mate	Mecha-nical	Elec-trical	Total	Ani-mate	Mecha-nical	Elec-trical
Punjab	0.13	2.19	0.64	2.96	4.4	74.0	21.6
Haryana	0.12	1.75	0.45	2.33	5.1	75.4	19.5
Rajasthan	0.08	0.34	0.11	0.53	14.6	63.4	21.7
India	0.27	0.46	0.29	1.02	26.9	44.6	28.5

Table 6. Milk and egg production in Trans-Gangetic Plain Region

State/Union Territory	Milk production ('000 tonnes)	Egg production (million)
Punjab	6,215	2,010
Haryana	4,062	507
Rajasthan	5,103	320
Delhi	257	61
Chandigarh	39	41

(b) Electrified villages and reliability of supply of electricity for agricultural purposes

All the villages of this region are electrified. Although there is shortage of electricity in this region, but State Governments accord top priority to ensure adequate power supply to the rural sector for different agricultural

State/Union Territory	Electricity for Agriculture (crore kWh)
Punjab	660.0
Haryana	365.3
Rajasthan	371.8
Delhi	7.5
Chandigarh	0.2

operations during peak season, viz. sowing, irrigation and planting/transplanting/threshing.

(ii) Present Scenario of Manufacture, Sale, Repair and Maintenance of Power Units and Agricultural Machinery and Suggestions for their Strengthening

Agricultural machinery and equipment are being manufactured by more than 300 registered small scale units in the States falling under this zone. Additionally, there are several thousand village artisans and black smiths engaged in the fabrication and repair of simple farm tools and spare parts. There are also as many as 9 tractor manufacturing units located in this zone which manufacture tractors in the horse power range of 20–70 hp. As regards repair, maintenance, overhauling and after sales services, there is a network of tractor dealer workshops as well as private repair shops and garages engaged in these activities. The private shops and garages lack trained and skilled technicians, proper tools and machinery apart from covered sheds, with the result that the repair and maintenance services are far from satisfactory. Bank loans to modernize these shops and garages as well as grant of stipend to train the mechanics can go a long way to improve the quality of repair and maintenance. This will also add to the life and reliability of the farm equipment and reduce the cost of operation, break downs and accidents during operation. Since every village now owns large number of tractors (15–20), it would be advisable to establish tractor and machinery service centers in selected villages or cluster of villages. Bank loans should be provided to qualified mechanics, unemployed youths and marginal farmers for this purpose.

(iii) Availability of New Designs of Improved Machinery

For most of the newly developed/modified farm equipment, detailed engineering drawings are not available. However, for new equipment of proven design, the detailed manufacturing drawings showing fits and tolerances, surface finish together with drawings of the required tooling, viz. Jigs and Fixtures should be made available to the manufactures against charges. The R&D institutions like PAU, Ludhiana and CCHAU, Hisar should prepare Computerized Data Banks for drawings of existing and futuristic machines for the benefit of the manufacturers. No design should be released at regional/national level without a set of detailed engineering drawings (manufacturing drawings of the equipment and its tooling), a technical bulletin, an Operator's Manual

and a Parts' Catalogue. Computerized drafting and drawings need to be provided.

(iv) Infrastructure and Programme for Promoting Awareness, Training, Demonstration and Extension of Agricultural Mechanization Programmes

Following infrastructures and institutions are available for these purposes in this zone:

1. SAUs and their Regional Research Stations.
2. KVKs.
3. ICAR and Govt. Institutes.
4. State Departments of Agriculture and Soil Conservation.
5. Indian Grain Research Institute (IGRI), Regional Station, Ludhiana.
6. Farmers Advisory Service.
7. Print and Electronic Media: Radio, Doordarshan and Newspapers.

(v) Facilities and Avenues for Training of Engineers, Diploma Holders, ITIs and Govt. Functionaries

For Training of Engineers

Agricultural Engineering Colleges and departments located in SAUs, National Technology Institutes, Govt., and Private Engineering Colleges.

For Training Diploma and Certificate Level Training

There is adequate number of Polytechnics, ATI, ITIs in the States falling under this zone.

For Government Functionaries

Agricultural Engineering Training Units in the SAUs, KVKs, SISI, ICAR and Govt. Institutions. Colleges of Agricultural Engineering, PAU, Ludhiana also has an independent Agricultural Engineering Training Unit for imparting training to field functionaries of various departments of the Punjab State. Such units ought to be established in other States as well. The Northern Region Farm Machinery Training and Testing Institute (NRFMTTI), an institution of Central Government located at Hisar is also involved in Training and Testing activities.

(vi) Facilities for R&D, Testing, Quality Control and Proposed Change, if any

R&D and Testing facilities available in this zone include the following:

1. Agricultural Engineering Colleges and Departments of Farm power and Machinery, Soil and Water engineering and Post-Harvest Technology in the SAUs such as PAU, Ludhiana; CCSHAU, Hisar; SAUs in the State of Rajasthan; Mechanical Engineering Research and Development Organization (MERADO), Ludhiana etc.
2. Evaluation and Testing of research prototypes is conducted by the research engineers of the above universities.
3. PAU, Ludhiana has a Farm Machinery Testing Centre for commercial and confidential testing of machines manufactured by the farm machinery firms. It has tested more than 150 such equipment since 1971.
4. Northern Region Farm Machinery Training and Testing Institute (NRFMTTI), Hisar also carries out the testing of various farm machines and power sources. This institution is under the Deptt. of Agriculture & Cooperation, Ministry of Agriculture, GOI and has excellent infrastructure.

As regards quality control of farm equipment, existing facilities are by no means adequate. There is no statutory requirement for quality control and testing of farm equipment. BIS has formulated more than 200 national standards and test codes for tractors, engines and farm equipment but their adoption by the manufacturers is almost negligible except in the case of tractors, irrigation pumps, diesel engines, sprayers and safe feeding systems for power threshers. Poor quality of agricultural machinery can be attributed to lack of adoption of modern manufacturing processes, lack of trained and qualified man power, lack of interchangeability of components, non-adoption of jigs, fixtures and tooling. Poor quality of equipment leads to higher repair and maintenance charges, frequency breakdowns and poor workmanship.

(vii) Facilities available for extension/training of farmers, artisans/farm women, Entrepreneurs etc.

Facilities available for extension/training of farmers, artisans/farm women, entrepreneurs etc. related to agricultural mechanization.

- (a) ICAR Institutes/Regional Stations, those doing work related to agricultural mechanization:
 - CIPHET, Punjab Agricultural University, Ludhiana-141 004, Punjab.
 - MERADO (Mech. Engg. Research and Development Organization)—an associate of CMERI, Durgapur.

- Northern Region Farm Machinery Training and Testing Institute, Hisar.
- (b) Agricultural Universities/Regional Stations (also highlight those doing work related to agricultural mechanization)
 - Punjab Agricultural University, Ludhiana, Punjab.
 - Chaudhary Charan Singh Haryana Agricultural University, Hisar, Haryana.
 - Rajasthan Agricultural University, Bikaner, Rajasthan.
 - Maharana Pratap University of Agriculture and Technology, Udaipur, Rajasthan.
 - Indian Agricultural Research Institute, Delhi.
 - Regional Station for Kandi Area, Ballawal Saunkhri, Hoshiarpur (Punjab).
 - Regional Station, Gurdaspur (Punjab).
 - Regional Station, Bhatinda (Punjab).
 - Regional Station, Faridkot (Punjab).
 - Regional Station, Rauni (Punjab).
 - (c) Offices of State Department of Agriculture, SISI units located in the zone.
 - Directorate of Agriculture, Punjab.
 - Directorate of Agriculture, Haryana.
 - Directorate of Agriculture, Rajasthan.

(viii) Facilities available for credit

In Punjab, Haryana, Rajasthan, Delhi and Chandigarh, almost all banks are giving credit for agriculture. The list of banks is as given below:

- NABARD, Chandigarh.
- State Bank of India.
- State Bank of Patiala.
- Punjab National Bank.
- Bank of Rajasthan.
- Co-operative Banks.
- Other Commercial Banks (including Regional Rural Banks).
- Number of Kisan Credit Card holders.

Punjab	10,99,646
Haryana	8,59,672
Rajasthan	18,42,073

(ix) Incentives, concessions, subsidies available to farmers/manufacturers of agricultural implements

- For purchase of small tractors up to 20 kW, subsidy is granted under the GOI scheme.
- For introduction of new farm machines such as Zero-Till Drill, Strip-Till Drill, Paddy Transplanter, Aero-Blast Sprayer, Tall-Crop (Cotton) sprayer, Harambha Thresher, the State

Governments have instituted a scheme for grant of 20 to 30% subsidy.

- Effective from the fiscal year 2003–2004, tractors, power tillers, hand tools and farm implements and equipment have been totally exempted from excise duty thus leading to 10 to 20% reduction in their cost.

14. **TRADITIONAL AND IMPROVED AGRICULTURAL IMPLEMENTS BEING USED BY THE FARMERS FOR DIFFERENT OPERATIONS AND IMPROVED AGRICULTURAL MACHINERY PROPOSED TO BE INTRODUCED FOR POPULARIZATION**

List of traditional & improved agricultural implements being used by the cultivators for different operations and improved agricultural machinery proposed to be introduced in the zone is given in Table 7.

15. **SWOT ANALYSIS OF AGRICULTURAL MECHANIZATION PROGRAMME IN THE REGION**

This agro climatic zone falls under the most progressive agricultural region of the country, which has been in the forefront for ushering in The Green Revolution in Indian Agriculture. By and large, the soils are alluvial. The irrigation intensity is high. In some cases like Punjab, it exceeds 95%. Likewise the cropping intensity is high and major part of this region has Paddy-Wheat cropping system. The SWOT Analysis of the region brings out the salient points pertaining to the region:

Strengths

- Reasonably flat land, mostly alluvial soils
- High irrigation intensity
- Water quality is by and large good
- Relatively high farm power availability
- Progressive peasantry
- Good network of manufacturers, repair and service workshops and agencies
- Reasonable Research and Development infrastructure and institutions
- Relatively easy availability of required farm tools and equipment
- Network for training-infrastructure exists
- Strong Institute-Industry liaison exists
- Good supporting infrastructure such as roads, electricity, grain markets, storages, banking/credit facilities available
- Highest density of tractor manufacturers in the

zone. There are as many as nine tractor manufacturers plus more than 300 registered farm machinery manufacturers

Weaknesses

- Lack of standardization and quality control of equipment
- Lack of mandatory testing
- Inadequate R&D infrastructure
- Sub-standard designs
- Lack of interchangeability of components
- Poor reliability
- Lack of modernization of manufacturing infrastructure/industries
- Lack of use of jigs and fixtures and poor production technology
- Absence of long term Agricultural Mechanization Policy
- Lack of proper mandatory safety standards and legislative Measures
- Inadequate and ill-equipped repair and maintenance shops
- Poor after sales service
- Proliferation of designs
- Defective credit policy
- High operating cost due to low annual use
- Absence of Farm Machinery Management Data regarding use-patterns, annual-use, breakdown frequency, repair and maintenance cost, reliability etc.

Opportunities

Of late there is a paradigm shift in agricultural policy to realize the goal of eco-friendly sustainable agriculture with reduced cost of production and high quality of produce. This is necessary to make Indian farmers globally competitive and to check further damage to natural resources of soil, water and ecology. Utmost emphasis is being laid in this zone to expeditiously diversify agriculture by introducing new crops and cropping systems by shifting the area from the Paddy-Wheat cropping system which is the predominant cropping system prevalent in this zone. Hence there are ample opportunities pertaining to agricultural mechanization. These include:

- Need for development and introduction of new state-of-art farm tools and machines for new crops and ventures especially for horticulture, floriculture, rain-fed and organic farming.
- Equipment for un-mechanized operations for crops grown need to be introduced in this zone.

Table 7. Traditional & improved implements being used by the cultivators and machinery proposed for different agricultural operations

Name	Traditional	Improved	Machinery proposed
Seed bed preparation			
Ploughing	Animal drawn plough	Mould Board plough	Tractor drawn MB plough
Harrowing	Animal drawn disc harrow	Tractor drawn disc harrow	–
Tilling/cultivating	–	Cultivator	Rotavator
Clod crushing	Planker (wooden)	Planker (mild steel)	Clod crusher
Land levelling	Suhaga	Leveller	Laser leveller
Planking	–	Planker scraper soil scoop	
Seeding/planting			
Rice	Broadcasting/manual transplanting	Manual transplanting	Tractor drawn transplanter
Wheat	Manual sowing	Bullock drawn seed drill	Tractor drawn seed drill, no till drill, roto till drill
Planting			
Vegetables	Manual	Bullock drawn planter	Tractor drawn multi-crop planter
Cotton	Manual	Inclined plate planter	Pneumatic planter
Maize	Manual flat planting	Maize planter	Pneumatic planter
Potato	Manual planting	Tractor-operated semi-automatic and automatic potato planter	Automatic potato planter
Weeding and hoeing			
Weeding/interculture	Khurpa/Kasola	Wheel hand hoe	Cultivators with sweeps, shovels and furrowers
Bund/furrow making	Bund former	Tractor-drawn bund former	
Spraying and dusting			
Spraying and dusting of field crops	Manual	Knap sack sprayer	Self propelled high clearance sprayer
Spraying of tall crops	Manual		
Spraying trees/shrubs	Manual	Foot sprayer	Aero blast sprayer
Irrigation			
Water lifting	Manual lifting	Tube-wells/canals	
Application of water (surface, sprinkler, drip)	Manually through furrows		Sprinkler/drip irrigation
Harvesting/digging/uprooting			
	Manual using sickles, spades, khurpa	Reaper, diggers	Combine harvesters, groundnut and potato diggers
Threshing/shelling			
	Manual	Power threshers	Combines/sheller
Winnowing/cleaning/grading			
	Manual with winnowing fan	Power cleaner and grader	Grain cleaner and graders
Straw management			
Reaping	Sickles	Reaper/chopper	Straw
Incorporating in soil	Plough	MB plough	Combine/chopper rotavator
Baling	Manual	Straw baler	–
Densifying	Manual	Straw baler	–
Stubble shaving	Manual	Stubble shaver	–

These include sugarcane harvesting, cotton picking and potato harvesting.

- Development and introduction of forage and fodder sowing and harvesting machinery.
- Development and introduction of machinery for harvesting, collecting and management of crop residues of paddy and other crops.
- Development and introduction of water harvesting, conserving machinery such as Laser-guided leveler, Ridge and Bed Planter, Tractor-operated pond excavation machinery, Drip and sprinkler irrigation systems.
- Need for manufacture of high capacity machinery suitable for contract and corporate farming as well as for custom hiring by farmers and entrepreneurs having Agri-business centers and ventures.

Threats

One has to guard against the following threats to derive full benefits from agricultural mechanization technology:

- Check over-mechanization leading to growing indebtedness of farmers in this zone.
- Check introduction and proliferation of sub-standard and hazardous equipment.
- Stop bank loan and credit for purchase of untested farm equipment.
- Adopt modern production/manufacturing technology to improve the quality of farm equipment, promote interchangeability and replacement of critical and fast moving components.
- Promote use of jigs and fixtures for manufacture of various components, frames, sub-assembly etc.
- Check unethical marketing practices being followed by dealers and manufacturers.
- Get BIS standards, norms and practices formulated for components and equipment for which these are non-existent. Same goes for new equipment. This is highly essential to ensure high quality, safety and reliability of farm equipment.
- Expand training facilities for mechanics, artisans and operators.
- Modernize small-scale farm machinery manufacturing units.
- Formulate policy for rational pricing of farm equipment and power sources to safeguard users' interests.
- Reform the credit policy to allow grant of credit for purchase of second hand tractors, abolish land mortgaging for purchase of tractors as well as

grant of credit for major overhauling, grant for bank loan for purchase of costly equipment such as combines etc.

16. LONG-TERM PROGRAMMES AND STRATEGIES FOR AGRICULTURAL MECHANIZATION PROGRAMMES IN THE ZONE

16.1 Challenges

1. To sustain agricultural production and productivity to meet ever-growing food needs of the burgeoning population as well as to create surpluses for export.
2. To prevent further damage to natural resources of soil, water and environment due to paddy-wheat cropping system and monoculture by diversifying the farming.
3. To check over-capitalization of agriculture, reduce cost of production and upgrade the quality of produce to make it globally competitive as necessitated under the GATT/WTO regime.
4. To augment avenues of employment for rural poor/unemployed youths.
5. To enhance the earning power of rural masses and raise their standard of living.
6. To check migration from rural areas to towns and cities.

16.2 Goals

1. To introduce eco-friendly, sustainable, multi-venture viable farming systems.
2. To diversify agriculture by reducing the area under paddy and wheat by greater emphasis on horticulture, dairy farming, poultry, fisheries and allied vocations such as mushroom growing, apiculture etc.
3. To reduce the cost of production and upgrade the quality of produce to attain global compatibility.
4. To reduce/curtail the losses at various stages. The losses for fruits and vegetables range from 40–50%.
5. To protect the natural resources of soil, water and environment. There is a sharp decline in soil quality and fertility, depletion in water-table, water and air pollution as well as phenomenal rise in new regimes of pests and weeds.
6. To develop field-worthy technologies for utilization and management of agricultural wastes and by-products.
7. To expand avenues of employment and income

generation in the rural areas through establishment of agro-industries, agri-business centers, agri-clinics etc.

16.3 Strategies for Agricultural mechanization

16.3.1 Farm Power

1. The Trans-Gangetic plain region has the highest intensity of tractors and highest degree of mechanization. There is a need for precision in field operations to reduce cost of operation and to maximize utilization efficiencies of costly inputs (seed, fertilizer, plant protection chemicals, water, machinery etc). Precision mechanization is required for conservation of natural resources (soil, water and environment) as well as to enhance utilization efficiency to further increase the productivity.
2. Farm power for mobile and stationary farm operations for this region is the highest in the country. The present level of about 3.5 kW/ha for Punjab needs to be sustained and be increased to about 4 kW/ha by 2020. Similarly, it needs to be increased from 2.5 kW/ha to 3.5 kW/ha for Haryana and from 0.65 to 2.5 kW/ha for Rajasthan by 2020. For stationary farm operations like water lifting, threshing, fodder cutting, cane crushing, cleaning, grading and other agro-processing and value addition activities, adequate electrical energy should be provided. For this, it should be necessary to ensure that the farmers get uninterrupted electrical power supply especially during peak season. In view of problems in supply of assured grid power, decentralized power generation using locally available resources such as agricultural residues, especially paddy straw need to be exploited in rural areas.
3. Research and development in use of alternate fuels and renewable energy sources such as Bio-diesel, biogas, Producer gas, and solar energy need to be intensified.

16.3.2 Improved Agricultural Implements and Machinery for Crop Production

4. Rice–wheat is the major cropping system of this region. Due to fast depletion in water table and decline in soil fertility, area under paddy needs to be reduced and replaced by other crops such as pulses, oilseeds, maize, fruits and vegetables. For both the existing and new crops to be introduced, top priority should be accorded to introduce

precision equipment for proper placement of inputs, to cut down the losses at different stages and to reduce cost of operation. This is necessary to maximize the production of the region.

5. For timeliness of operations, reduced cost and energy saving in tillage and sowing/planting/transplanting of crops grown in this region, adoption of efficient seedbed equipment including rotavators, conservation tillage technologies (zero-till drills, strip-till drills, roto-drills, till-plant machines, raised bed planters, ridger, seeder etc.) together with precision drills and planters (pneumatic drill/planters and transplanters) for paddy and different vegetable crops need to be introduced. Presently transplanting and planting mechanization for paddy, sugarcane and cotton crops is at fairly low level. Suitable machines need to be developed and introduced.
6. Power operated weeders (both self-propelled and tractor operated) for narrow and wider row crops need to be introduced and popularized. High clearance tractors with narrow tyres are required to be introduced for intercultural operations in line with the current emphasis on integrated weed and pest management.
7. Efficient plant protection equipment especially aero-blast sprayers for orchards and electro-static sprayers for field crops need to be developed and introduced for maximum economy in spraying and for better deposition of chemicals.
8. Harvesting for most of the crops grown in this region with the exception of wheat, paddy and potato is still done with sickles. Harvesting of wheat and paddy is highly mechanized (80 to 90%) in this region. Reapers, combines and diggers are available. However, combines and harvesters for other crops (Sorghum, pearl millets, maize, pulses, oil seeds, sugarcane, cotton, safflowers, sunflowers, castor, etc) need to be introduced and popularized for time, cost and loss reduction as well as quality up gradation.
9. This region has the highest intensity of mechanization in threshing of wheat, rice, sorghum, pulses and oil seeds. Threshers for new crops such as pigeon pea, safflower, etc need to be developed and popularized. In view of the increasing trend for adoption of higher horse power tractors (above 40 hp) and custom higher work, emphasis should be laid on development and introduction of efficient high capacity multi-crop threshers.

10. The futuristic farm equipment in the following areas are needed for this zone; for which R&D efforts with strong institution-industry liaison is necessary.
- Machinery for resource conservation, organic farming, integrated nutrient, weed and pesticide management.
 - Rotary tillage and rotary cultivation machinery.
 - Laser guided levellers, low-tunnel and plastic mulch laying machines.
 - Harvesters and combines for sugarcane and cotton picking.
 - Aero blast sprayers for orchards and vineyards as well as electro-static sprayers for grain crops, vegetables, pulses and oilseeds.
 - High capacity precision machinery for seeding (pneumatic planters, precision drills, transplanters), chemical application and threshing.
 - Forage planting and harvesting machinery.
 - Safe and efficient transport vehicles for haulage of wheat straw, paddy husk, sugarcane, fodder etc
11. In view of the fast declining water table, irrigation resources particularly the ground water need to be judiciously used. Crops with high water requirement and comparatively low returns need to be replaced with high value and high return and less water consuming crops. Diversification of paddy wheat cropping system has assumed critical significance for this region to check rapid decline in water table and soil fertility. For increasing production and productivity, optimum use of water through efficient water management practices for water conservation, rain water harvesting, recharging, reducing conveyance losses through lining of water courses, use of plastic pipes are necessary. Precision land leveling and use of sprinklers and drip irrigation systems for water economy need to be adopted.
12. For construction of farm ponds, bunds, drainage channels, different types of earth moving equipment such as laser guided land levellers, trenchers, angle dozers, drudgers, and scrapers are required. R&D to use higher horse power tractors already available with the farmers for some of these equipment/earth moving operations need to be pursued expeditiously. Simultaneously custom hiring operations for earth moving operations need to be encouraged.
13. In order to make efficient use of human and animal energy, improved, efficient and ergonomically designed hand tools and matching animal operated equipment for different operations need to be promoted and popularized. Ergonomically well designed gadgets and devices for farm women also need to be developed and introduced to reduce the energy expenditure and drudgery.
14. There is a distinct shift towards adoption of higher horse power (40 hp and above) tractors in this region. However, good quality matching machines and equipment are not available. To remove this bottleneck, R&D efforts to develop and introduce good quality state-of-art equipment need to be accelerated. This calls for strong industry-institution liaison.
15. The annual use of tractors in this zone is barely 400–500 hours. This leads to high cost of operation. This needs to be corrected by introducing machines for un-mechanized operations of existing and new crops being introduced in cropping system in this zone.
- 16.3.3 Mechanization of Horticultural Crops**
16. Horticulture is the key area for diversification of agriculture in this region. Equipment for mechanization of orchard crops for pit making, transplanting of saplings, spraying, pruning, harvesting of fruits etc need to be identified/imported/designed, manufactured, introduced and popularized. Similarly different operations for vegetable crops need to be mechanized. Latest equipment for seeding, planting and transplanting of seedlings, weeding, hoeing and earthing, irrigation, spraying, harvesting, picking/plucking/harvesting need to be introduced through importation as well as indigenous R&D and manufacturing.
17. Equipment for laying plastic mulch, low plastic tunnels for cultivation of vegetables, cut flowers need to be introduced and popularized.
18. Green house technology has good scope for growing seedlings, flowers, high value off-season vegetables and some fruit crops. This technology need to be promoted as a part of diversification efforts. Equipment for mechanization of cultivation in green houses need to be introduced and popularized. R&D efforts in this area need to be intensified.

16.3.4 Feeds and Fodders

19. In view of the large population of milch cattle and draft animals, it is necessary to introduce appropriate farm equipment for seeding, harvesting, baling, silage making, and machinery for making feed blocks and pallets.

16.3.5 Biomass Management

20. Equipment for harvesting, collection, densification, fortification, handling and transport of crop residues are required to be introduced in adequate numbers for making efficient utilization of straw and other crop residues which are available in large quantity in this region. Paddy straw which is presently burnt and causes environmental pollution can be gainfully utilized for power generation and allied usages. Management of paddy straw is no doubt a burning problem for this region.
21. In view of the highest per hectare use of pesticides in this region, utmost emphasis needs being laid on integrated pest management and organic farming. Hence the demand for good quality manure and compost is fast increasing. Equipment for handling, transport and application of manure and compost including biogas slurry are required. Such equipment need to be designed and introduced in adequate numbers.
22. Equipment for clearing of shrubs, weeds, and grasses from roadside are required.

16.3.6 On-farm Post Harvest Technology

23. Post-harvest equipment and technology are required for cleaning, grading, drying, cooling, evaporative cooling, storage, cold storage and handling of farm produce to improve its quality and shelf-life. Cool chains for transport of perishable materials like fruits, vegetables, milk and milk products, fish, meat etc. are required to reduce losses.
24. Agro-processing activities need to be strengthened in the production catchments to reduce losses, minimize transport cost and to enhance income and employment opportunities for rural masses/entrepreneurs. Development, manufacturing and introduction of efficient low capacity rice shellers, hullers, decorticators, oil expellers, pulse mills, dryers, cleaners, graders, conveyors is of critical importance for this region to promote agro-processing centres in the rural areas.

25. Grain handling operations in the Grain Markets are quite labour, time and cost intensive. Resultantly these lead to excessive loss and low quality. Hence, mechanization of Grain Markets both for cereal crops as well as for vegetables and fruits is of critical importance for this region.

16.3.7 Infrastructural Improvements

26. Testing facilities for agricultural machinery and agro-products for quality control need to be further strengthened in this region. Manufacturers, processors and R&D agencies need to intensify their efforts to improve the quality of the products for global competition.
27. Testing facilities already existing in this region need to be strengthened and modernized. In fact the instrumentation and data acquisition system in most of the existing setups is far from satisfactory. These institutions also need to be approved for testing of various types of agricultural machinery and quality certification of agri-products, wherever required.
28. A Display Centre of Improved Agricultural Machinery need to be established in this region with full information and video clippings of the working of different types of equipment, from where the farmers/extension workers/policy makers etc can seek information regarding different types of agricultural machinery, their specifications, source of availability and cost. An experienced agricultural engineer should man this center. The center should also acquire the information regarding latest agricultural machinery from overseas countries.
29. For providing information to the farmers, information kiosks and centers need to be established by Department of Agriculture at selected locations. These centers can provide information on soil, crop, variety, fertilizer, chemicals, diseases and pest, irrigation requirements, loans, subsidies etc. Adequate information on the availability of farm equipment, sources of supply, costs etc. are not available at these information centers. Farm machinery being a costly input to agriculture, farmers should be provided information and properly guided in selection of appropriate equipment for them.
30. Farm machinery exhibitions/displays and demonstrations need to be organized at selected locations in the region from time to time and farmers should be invited to get information about

- latest farm tools and equipment. KVKs also need to be associated with this activity.
31. Requisite facilities need to be created and expanded for training of trainers, farmers, drivers/operators, mechanics, and manufacturers to support the agricultural mechanization programmes training centres in the SAUs, KVKs, Nationalized banks, Fertilizer companies, tractor/power tiller/combine/engine manufacturers need to be involved in organizing training regarding latest technologies recommended for this region.
 32. Training programmes need to be organized for the entrepreneurs in manufacture/running of custom service centres/Agri-clinics/repair and maintenance workshops and providing contract services for different farm operations.
 33. To promote awareness amongst the farmers and extension workers, regular programmes should be broadcast/telecast on radio and TV networks. Video films on the working of different equipment need to be prepared and shown to the farmers. Front line demonstrations of new equipment need to be conducted in farmers' fields and large number of farmers needs to be invited to witness such demonstration.
 34. This region has elaborate facilities for the manufacture of different types of agricultural machinery. Manufacturers need to be provided with latest designs and due incentives for manufacture good quality equipment at competitive prices.
 35. Necessary mechanism and procedures need to be developed to collect information about the production and sale of different types of agricultural machinery in the State, on the same pattern as for crop production and yield data. This will help in indicating the present trends and projecting future demand of different types of agricultural machinery. This, in turn, will help in better planning for future agricultural mechanization programmes. Such data need to be published annually and be made available on-line/internet.
 36. To extend the benefits of improved high capacity agricultural machinery for different categories of farmers, custom services of agricultural machinery by private entrepreneurs need to be encouraged and promoted. Entrepreneurs, farmers, cooperatives engaged in custom hiring should be provided incentives and granted long-term loans on concessional rate of interest. This will boost use of efficient agricultural machinery for timely farm operations, reduce cost of production and improve the quality of produce.
 37. Visits of progressive farmers should be organized to other States/countries to encourage them to see the modern farms and use of improved agricultural machinery. Similar visits of selected manufacturers of the region should be organized to progressive States and overseas countries to see modern farms, manufacturing units and get information about different types of improved agricultural machinery. A team of Research Engineers/Scientists, manufacturers, policy makers should be sent to National/International Farm Machinery Shows to identify potential machinery for introduction in the region/State/Indian conditions for future adoption and popularization.
 38. In view of wide spread use of diesel engines, electric motors and tractors by the farmers in this region, there is a need for scientific management to enhance the operational efficiency of these power sources through judicious selection, proper installation, training of operators and users, proper service, maintenance and repair. Hence different aspects of Farm Machinery Management need to be strengthened and a data base of mechanization related information needs to be created for this zone.

16.3.8 Institutional Framework

39. A Farm Mechanization Development Council, under the Chairmanship of Minister of Agriculture be setup at the State level to plan, guide, review and monitor the programmes related to agricultural mechanization in the State. This council should be represented by the officials of the Department of Agriculture, Agricultural Engineering, Animal Husbandry, Horticulture, Fisheries, Irrigation, industries, manufacturers of agricultural machinery, leading banks, Agro-Industries Corporation, State Planning Commission, ICAR Institutes in the region, State Agricultural Universities and Progressive farmers. This council should meet twice a year.
40. The existing infrastructure and manpower for planning, execution and monitoring of agricultural mechanization and agro-processing activities in this region are grossly inadequate. A study of the requirements for engineering services was conducted by Arjan Singh Committee set up

by Government of Punjab in 1988. This committee had strongly recommended the need to setup a State Level Agriculture Mechanization Board/Directorate of Agricultural Engineering. This recommendation still holds good to check the ever increasing burden on the farmers due to faulty selection, inefficient use coupled with large number of accidents occurring on tractors and agricultural machinery. A Monitoring Cell also needs to be established in the Directorate of agriculture/Agricultural engineering in each State in this region.

16.3.9 Policy Issues

41. To put agricultural mechanization on a sound footing there is need for a long-term Agricultural Mechanization Policy at National and State levels.
42. In order to encourage use of energy efficient equipment, the farmers should not be provided free electricity. Rather the electricity should be provided to them at subsidized rates and they should be given incentives in the support price of food grains.
43. Farmers should be encouraged to insure their farm equipment and to provide an insurance cover to the farm labour. Group insurance scheme for equipment like tractors, power tillers, combines, threshers etc need to be initiated and the premium rate should be 0.5% or less of the value of the machinery to be insured.
44. In view of high intensity of electro-mechanical power sources, viz. electric motors, diesel engines, tractors and machines, number of accidents has assumed alarming proportions. Apart from user education and provision of in-built safety devices, there is a need for legislative measures to make it mandatory to provide necessary safety devices and modification on ROPS on all tractors of 25 kW and above.
45. Farmers' Machinery Cooperatives need to be established to provide an efficient network of custom-hire services. To ensure efficient service, repair and maintenance of power sources, service centers in cluster of villages need to be established with help of bank financing.
46. Adequate funds need to be provided for conducting front line demonstration of newly developed farm equipment. Front-line Demonstration can promote awareness among the farmers and also help to debug the Defects/Weakness, if any, noticed in the new equipment. There is need to suitably revised the credit policy for purchase of tractors, which is based on land mortgaging. It needs to be replaced by hypothecation of machine for which credit is provided as is the practice for other commercial vehicles.

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