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**Long-term Mechanization  
Strategy Papers for Different  
Agro Climatic Zones**



## Long-term Strategies and Programmes for Mechanization of Agriculture in Agro Climatic Zone-I : Western Himalayan region

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1. NAME OF AGRO CLIMATIC ZONE : Western Himalayan region
2. STATES UNDER THIS ZONE : Himachal Pradesh, Jammu and Kashmir, Uttaranchal



### 3. SUB-AGRO-CLIMATIC ZONES WITH THEIR CHARACTERIZATION

The hill regions of Western Himalayas consists of three States namely Jammu & Kashmir, Himachal Pradesh and Uttaranchal. The region has much diversity. The valleys receive good rainfall and have rich soils though the temperate zones of Ladakh face climatic barriers against agricultural growth. High soil erosion also reduces fertility.

There are three sub-zones in this zone.

#### 3.1 High Altitude Temperate

This covers districts in Jammu and Kashmir and Pakistan and China occupied Kashmir. The districts are Jammu, Baramula, Anantnag, Pulwama, Srinagar, Badgara, Kathua, Kargil, Ladakh, Kupwara, Punch, Rajauri and Udhampur. Besides, the region also includes the Chilas, Gilgit, Wazarat, Mirpur and Tribal Territory districts which are occupied by Pakistan and China.

This region is interspersed with a series of mountain ranges running parallel to each other, east to west. The Indus river system has carved out a number of valleys in which agriculture is practiced—Elevation increases from about 330 metres in Jammu to 3,505 metres in Ladakh and rainfall decreases from about 1,052 mm in Jammu to 92 mm in Leh.

#### 3.2 High Hill Temperate

This sub-zone consists of two distinct regions—the High Hill Temperate and the Hill Temperate. The High Hill Temperate region comprises of only two sparsely populated districts—Lahul and Spiti and Kinnaur in north Himachal Pradesh. The population is largely tribal and the land is mostly fallow. Only seven per cent of the area is under forest cover and about three per cent is cultivated. Compared to the lower and middle hill regions, this region has better irrigation facilities. The pre-dominant source of irrigation is the *khul*. There is about 800 mm of rains in a year and the soil is mountainous and skeletal. Farming is practiced mostly on steep slopes without much soil conservation measures leading to heavy soil erosion.

The Hill Temperate region in this sub-zone covers the better part of the State of Himachal Pradesh—Nearly two-thirds of the geographical area falls under this region. It covers the districts of Bilaspur, Chamba, Hamirpur, Kangra, Kullu, Mandi, Shimla, Sirmaur, Solan and Una. About a fifth of the land is cultivated and nearly 31% is under forests. Nearly 40% of the geographical area is available for cultivation. Only about 12% of the net sown area is irrigated. The major source of irrigation is the *khul*.

The climate is humid and sub temperate and the average annual rainfall is 1,300 mm. About three-fourths of the normal precipitation is from the South-west monsoon during June to September. The winter and pre-monsoon showers are also significant with a precipitation of between 150–175 mm in each of these two seasons. The soil is largely brown alluvial.

#### 3.3 Valley Temperate

This sub- zone consists of Uttarkashi, Dehra Dun, Haridwar, Chamoli, Tehri Garhwal, Garhwal, Almora, Nainital, Udham Singh Nagar and Pithoragarh districts of Uttaranchal State.

This region has a high forest cover of nearly 65% by the official definition. However, a large part of this is thin on vegetative cover. Only 12% of the land is cultivated. About 37% of the cultivated area is irrigated. The region receives about 1,675 mm of rain annually.

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

The three sub-agro climatic zones of this region as mentioned above are divided into four agro-ecological regions as shown in Table 1.

The conservation of natural resources in the Himalayan region is an issue of utmost concern for sustainable agricultural development and improving livelihood securities of the local inhabitants. Ruthless and unauthorized exploitation of natural resources is affecting long-term sustainability of Himalayan agricultural production system, which mainly revolves around crop production, horticulture, livestock, and forest and to some extent fisheries. Glaciers and glacial melts are steadily declining.

A large number of crops—cereals, pulse, oilseeds and others have been cultivated in the region with an objective of attaining self sufficiency in food. Horticultural crops are well adapted to this region, these include fruits (apple, almond, walnut, plum, peach, cherry and apricots), vegetables (brinjal, chillies, potato, pea, cabbage, cauliflower, knol khol, turnips, onion, garlic etc.), spices (saffron, Kala zeera), and flowers (rose, gladiolus, marigold, tulip, carnation, chrysanthemums, nargis etc.). Forests occupy 60% of the total geographical area of the Himalayan ecosystem, though substantial area has been reduced to scrub forests. The agrarian economy of the hills is heavily dependent on forest and pasture lands, for energy supply, fodder, non-timber products and livestock rearing. This vital sector of hill economy, however, due to high

Table 1. Agro-ecological regions and livelihood production systems in the Western Himalayan zone

Region	Climate, altitude (m, amsl)	Livelihood production system	Parts of the State covered		
			Jammu and Kashmir	Himachal Pradesh	Uttaranchal
Region I Sub-montane and Low Hills	Sub-tropical 200–800	Agri-livestock fish-horticulture	Jammu and plains of Udhampur district	Una, Bilaspur, Hamirpur and parts of Sirmaur, Kangra Solan and Chamba districts	Parts of Pauri Garhwal, Dehra Dun, Almora and Pithoragarh districts
Region II Mid Hills	Sub-humid 801–1,800	Agri-horti- livestock- fish	Hilly areas of Doda, Udhampur, Rajauri and Punch districts	Kangra tehsils of Palampur and Shimla district, and parts of Mandi, Solan, Kullu, Chamba and Sirmaur	Parts of all districts
Region III High Hills	Temperate 1,801–2,200	Agri-horti- livestock-pasture- fish	Srinagar, Budgam, Anantnag, Pulwama, Baramula and Kupwara districts Leh and Kargil districts	Shimla district (except Rampur tehsil) and parts of Kullu, Solan, Chamba, Mandi, Kangra and Sirmaur district	Major parts of Pithoragarh, Uttarkashi and small part of Chamoli and Tehri Garhwal
Region IV Very High Hills	Temperate dry > 2,200	Livestock – silvipasture – agriculture	Leh and Kargil districts	Kinnaur, Lahaul and Spiti, and Pangi and Bharmour tehsils of Chamba	Parts of Uttarkashi, Chamoli, Pithoragarh and Almora districts

biotic pressures and abiotic factors is degrading. There had been a gradual decrease in the dense forest areas. Massive corrective measures are therefore being taken by government at strategic, operational and policy level. Cultivable lands are limited, little scope of cultivating fodder as a result livestock pressure is relatively higher in the Himalayas than in the plains. Cold-water aquaculture has a vast potential for horizontal and vertical expansion.

Region has vast potential of hydroelectric power, which has not been fully tapped. There is general paucity of electrical power, which hampers agro-industrial and socio-economic development especially in J&K. Potential also exists for geothermal energy.

##### 5. OPERATIONAL LAND HOLDING PATTERN BY MAJOR SIZE GROUP (MARGINAL, SMALL, SEMI-MEDIUM, MEDIUM AND LARGE HOLDING SIZE)

The operational land holdings are shown in Table 2.

Table 2. 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
Jammu and Kashmir	1,041	187	89	18	Neg.	1,336
Himachal Pradesh	556	173	95	34	5	863
Uttaranchal	NA	NA	NA	NA	NA	NA

Note: Neg. - Negligible; NA - Not Available.

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.

## 6. IMPORTANT SOIL TYPES

While Ladakh and parts of Lahaul and Spiti have skeletal, calcareous soils with alkaline reaction, the rest of the region have soils which are shallow to deep loamy, forest and podzolic brown with medium to high organic matter and acidic in reaction.

## 7. CLIMATE AND ANNUAL RAINFALL

The mean total annual rainfall is < 150 mm for Western Himalayan cold arid region, 1,000–2,000 mm for northern plain, hot sub-humid region, and 1,600–2,000 mm for Western Himalayan warm sub-humid region (Sehgal *et al.* 1990).

## 8. POPULATION AND POPULATION DENSITY OF THE ZONE

The structure of the population in the Zone is given in Table 3.

Table 3. Distribution of population, sex ratio, density, % decadal growth rate—2001

	Total population			Sex ratio (females/ 1,000 males)	Density/km <sup>2</sup>	% Decadal growth	
	Persons	Males	Females			1981–91	1991–01
Jammu and Kashmir	1,01,43,700	53,60,926	47,82,774	900	99	30.34	29.98
Himachal Pradesh	60,77,900	30,87,940	29,89,960	970	109	20.79	17.54
Uttaranchal	84,89,349	43,25,924	41,63,425	964	159	24.23	19.34
India*	1,02,88,30,774	53,22,63,021	49,65,67,753	933	324	23.86	21.56

Notes: (1) The percentage decadal growth of population of Assam in 1981 and Jammu and Kashmir in 1991 have been worked out by interpolation as 1981 census in Assam and 1991 census in Jammu and Kashmir could not be conducted owing to disturbed conditions; (2) \*2001 census figures are provisional for Nagaland, Manipur and India.

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

## 9. BRIEF SCENARIO OF AGRICULTURE SECTOR

In the Western Himalayas, wheat is the principal crop (36.6% area) followed by rice (31.0%) and maize (26.2%). The minor millets are mainly confined to the Uttaranchal. Area covered under oilseeds is 3.5%.

Area under cash and commercial crops in the western Himalayas is very little except for 28,000 ha potato and 47,000 ha sugarcane in UC-Tarai and a little in HP. There is some area under Saffron and Kala-Zeera in J&K and under tea in HP.

Crop diversification towards less perishable horticultural crops like walnut, almond, pistachio, chilgoza, olive, kalazeera, saffron and pomegranate in western Himalayan region is essential to earn foreign exchange and reduce pressure on the available resources for creating additional infrastructure facilities. Western

Himalaya is deficit in food grains. Because of remoteness, transport costs are very high. Therefore, major research thrusts in the past were given to variety development and crop and nutrient management practices to boost agricultural productivity. Improved technologies have been developed which are superior to the traditional practices in terms of productivity and profitability but not comparable to the Indo-Gangetic plains.

Under rainfed condition, mono-crop of cereals (rice, wheat, maize) may give net return of Rs 9,000 to 10,000 per ha, a catchup *rabi* of pulses and oilseed increases net returns to about Rs 12,000 per ha. Rice-wheat under irrigated conditions can fetch about Rs 25,000 per ha against which vegetable crops can give net returns 4 to 8 times. Three crops of vegetables can be taken during the season, the important rotations being tomato-tomato-cauliflower, tomato-cauliflower-radish, cabbage-cabbage-cauliflower, french bean-french bean-

cauliflower, capsicum/brinjal-cabbage-radish, tomato-pea etc.

## 10. BRIEF SCENARIO OF ANIMAL HUSBANDRY SECTOR

The Western Himalayan region supports a large population of domestic animals, which are used for milk, meat, fur, wool, hide, transportation and manure. Rearing of cattle, sheep and goats is prevalent in western Himalayas. Migratory livestock husbandry particularly small ruminants, sheep and goat are still in vogue and main source of livelihood for about 15% population in J&K. In J&K, the people are largely non-vegetarian but domestic production of meat is hardly 50% of the requirement.

## 11. BRIEF SCENARIO OF FISHERIES SECTOR

Aquaculture has good potential in the Western

Himalayas. However, it is largely cold-water fisheries and aquaculture. It can be expanded both vertically and horizontally because of high precipitation and resultant runoff favouring both rainfed or runoff fed aquaculture.

## 12. IRRIGATED AREA AND SOURCE OF IRRIGATION

The Himalayan region has plenty of water resources but more than 2/3rd of its gross cropped area is rainfed. Hilly and mountainous terrain makes harnessing of river waters difficult. Hill ranges are snow covered and provide perennial flow to down plains. About 13% of ground water potential is being used for irrigation.

## 13 INFRASTRUCTURAL FACILITIES AVAILABLE IN THE ZONE

### 13.1 Metalled Road

Inaccessibility is a major impediment to the overall development of the hill region in general and adoption of high-value low-volume land-based activities in particular. Villages are dispersed from the valley up to the hilltop with a relatively low density. Construction of road is difficult, maintenance expensive, environmentally undesirable and economically less attractive due to low population density scattered in the landscape. Road density is satisfactory in HP only.

### 13.2 Rural electrification

While all villages have been electrified in J&K and Himachal Pradesh, only 79% of Uttaranchal villages have been electrified. However the electric supply is poor and there are frequent cuts.

### 13.3 Research and Training

The region has 12 ICAR Institutional Centres, four Agricultural Universities, one University of Horticulture and Forestry, a large number of research stations and sub-stations and 23 KVKs.

## 14. MANUFACTURE AND MARKETING OF FARM EQUIPMENT

There are no specialized markets for the sale and purchase of farm implements in the region. Neither there is much manufacturing of farm equipment except in plains of Uttaranchal in Rudrapur, in Palampur (HP) and Jammu (J&K). Traditional hand tools and implements are made and maintained by local craftsman. Some of these craftsmen have taken a few improved tools and implements for fabrication and marketing from their

workshop. Divisional level Govt. Agricultural Engineering Workshops exist in both Jammu and Kashmir Divisions of J&K which manufacture and market tools and implements farmers through various programs and subsidies.

In Himachal Pradesh, there is a scheme for mechanization of agriculture at CSKHPKV, Palampur. Government is providing 100% transport subsidy within the State. A total of 82,500 improved agricultural implements were distributed during 2002–03 (Rs 4 crore earmarked under plan expenses).

## 15. SWOT ANALYSIS OF MECHANIZATION PROGRAMME IN THE REGION

### Strengths

- Manufacturing of agricultural machineries and farm tools, implements especially through village artisans, is gaining momentum
- A number of institutions exists where there are agricultural engineering programmes which can play lead roles, however, these need strengthening.
- Processing and value addition through PHT, especially horticultural crops has arrived, planners and policy makers keen to promote it.
- Tradition of custom servicing and hiring exists in the region.
- Annual sale of pumping sets, tractors, power tillers and their matching equipment, power threshers etc. on rise.

### Weaknesses

- Land holdings are very small, topography is undulating and terraced irregular shape fields makes mechanization difficult with farm equipment available in the market.
- Mechanization has still not reached in many of the agricultural and produced management activities because of poor extension in the field of mechanization and agro-processing.
- Safety and ergonomic considerations have not adequately permeated in available designs of hand tools implements and machines.
- Hardly any mechanization has taken place in horticultural crop cultivation and hill agriculture in general.
- Reliable statistical data on mechanization, PHT and agro-processing are lacking, little data base for micro-level planning.

## Opportunities

- Farmers are keen to have improved tools, implements and machines.
- Mechanization minimizes drudging to farm workers and removes social taboos associated with certain farm operations thereby facilitating rural educated youth taking agriculture as vocation
- Many of the commercially available farm equipment have scope of use in the region including small tractors and power tillers, pumping sets, drips and sprinklers, tillage, seeding and planting equipment, horticultural tools, mini-modern processing units etc.
- Planners and policy makers are receptive to promoting mechanization and on-farm agro-processing and values addition.
- Farmers and rural people in general can supplement their income by taking post-harvest-technologies, primary processing packaging and scientific storage, meeting their own needs at least cost and marketing surpluses after value addition.
- Limitations imposed by cold climate can be overcome by taking up surface covered cultivation/greenhouse technology, agricultural structures and environment control measures.
- Mechanization can create jobs for educated rural youth.

## Threats

- Failure to carry out a systematic mechanization programme in Western Himalayas may result in reduced production, productivity and quality of field and horticultural crops.
- Stunted rural economy and political vulnerabilities
- Failure to make agriculture and rural living attractive and/or remunerative through mechanization, will result in exodus to urban areas creating labour shortages and drain on rural skills and entrepreneurship.

## 16. STRATEGY FOR AGRICULTURAL MECHANIZATION IN WESTERN HIMALAYAN REGION

### 16.1 Farm Power

1. Mechanization is essential for timeliness in field operations and precision in placement of costly inputs to increase productivity, reduce unit cost of production and drudging in farm operations as

well as conservation of natural resources.

2. For intensification of agriculture farm power availability should be increased from the present level of about 0.60 kW/ha to about 2.0 kW/ha in Jammu and Kashmir, by 2020 as well as other States of Western Himalaya. For stationary operations like water lifting, threshing, chaff cutting, cane crushing, cleaning, grading and other agro-processing and value addition activities, adequate electrical energy is essential and it should be provided. If grid power availability is a limitation, decentralized power generation using locally available materials could be developed.
3. Equipment and power units suitable for hill agriculture, agro-processing and rural living should be selected, tested, adapted and introduced in the region. Power units like extra light power tillers, hill-side tractors, efficient power operated tools and implements for horticultural crops should be procured and evaluated for adoption.

### 16.2 Improved Agricultural Implements and Machinery for Crop Production

4. Rice–wheat cropping system has potential to provide food and feed security in the region hence priorities should be given to these crops by adopting improved varieties along with recommended package of practices and equipment. For secure rice-wheat rotation, short duration cold tolerant rice and wheat varieties and hybrids are needed.
5. Periodic use of sub-soilers and equipment for deep tillage for breaking hardpan and eradication of perennial weeds is desirable.
6. For efficiency and economy in tillage and sowing/planting/transplanting operations, large scale adoption of rotavators, conservation tillage technologies (zero till drills, strip till drills, roto-drills, till-plant machines, raised bed planters, ridger seeder etc.) and promotion of precision drills, planters and transplanters should be given high priorities.
7. For timely and efficient plant protection, Aero-blast sprayers, orchard sprayers and electro-static spraying equipment are required to be introduced.
8. Improved harvesting equipment like serrated sickles, fruit pluckers, vertical conveyor reapers and combine harvester should be introduced.
9. To overcome drudgery in threshing and cleaning of cereals, pulses and oilseeds appropriate power threshers should be popularized.

10. Crops with high water requirement and comparatively low returns like rice should be diversified with low water requirement, high value and high return crops as recommended by agricultural scientists and experts.
11. For increasing production and productivity snow melt and rain water harvesting, conservation, storage, efficient conveyance and application using plastic pipes, laser land levelers, sprinklers and drip irrigation systems should be intensively promoted.
12. Power operated trenchers, angle dozers, drudgers, buck scrapers and other earth moving machinery will be required to be introduced in the region for making farm ponds, bunds and terraces, irrigation channels and waterways.
13. For rational use of human and animal energy, improved, efficient and ergonomically designed hand tools and matching animal operated equipment for different operations like seed bed preparation, sowing/planting, weeding/interculture etc. should be adopted, developed and popularized.
14. In the foot hill and 'tarai' areas of the region conventional power operated equipment for seed-bed preparation, sowing, plant protection, harvesting, threshing, combining, etc. are relevant, hence should be promoted.
15. Predominance of small and marginal farms in the region demands well developed custom servicing in power equipment and machinery through entrepreneurs, self-help groups and cooperatives.

### **16.3 Mechanization of Horticulture Crops**

16. Fruit crop mechanization equipment for pit making, transplanting of saplings, pruning, spraying in tall crops, harvesting of fruits etc. need to be identified/adopted/developed and popularized.
17. For vegetable crop mechanization equipment for seed-bed preparation, planting, transplanting of seedlings, interculture, irrigation, spraying harvesting etc., need to be identified/developed and introduced.
18. Modern manual and power operated garden tools and equipment will have to be introduced and popularized for floriculture, landscape and ornamental horticulture.
19. Plasticulture has wide scope in hill agriculture demanding intensive R&D and extension effort specially in green houses, low and high tunnels,

plastic mulches, micro-irrigation and mist formation.

### **16.4 Feeds and Fodders**

20. Equipment for harvesting of fodder crops, hay baling making silage, feed blocks, feed pallets will be required to be introduced and popularized in future.
21. For efficient use of scarce fodder, feeding chopped fodder should be popularized.

### **16.5 Biomass Management**

22. To support organic farming equipment for mechanized composting, compost palliation, handling, transport and application of manure in the field in liquid and solid forms will be required. Such equipment will be required to be imported/adopted/developed and popularized.

### **16.6 On-farm Post Harvest Technology**

23. Post harvest equipment and technology are needed for cleaning, grading, drying, cooling, evaporative cooling, storage, cold storage and handling of farm produce to improve their quality and shelf-life. Cold chains for transport of perishable products like fruits, vegetables, milk and milk products, fish, meat etc. are required to transport with minimum losses.
24. Agro-processing activities should be promoted in the production catchments to reduce losses, have primary processed products for local need at the least cost, transform perishables into durable products, minimize transport cost and to increase income and employment opportunities in rural areas.
25. Expansion and upgrading of horticultural activities requires appropriate short and medium term storage facilities for horticultural produce and products.

### **16.7 Infrastructural Improvements**

26. Testing facilities for agricultural machinery and agro-products for quality control should be created in the region preferably at Department/ College of Agricultural Engineering and manufacturers, processors and experts should be helped in improving the quality of their products.
27. For creating awareness amongst the farmers, extension workers and entrepreneurs of the region, Display Centres of Improved Agricultural Machinery be established with working

prototypes, full information and video clippings. An experienced agricultural engineer should man this Center.

28. Information centres should be established by development departments to provide information to the farmers using print and electronic media.
29. Farm machinery exhibitions and demonstrations should be organized at important places in the region every year for the benefit of farmers.
30. Facilities should be created and expanded for training of trainers, farmers, drivers/operators, mechanics, and manufacturers to support the agricultural mechanization programmes in public and private sector.
31. Training programmes should 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.
32. Quality manufacturers of agricultural machinery in the region should be encouraged, given incentives and orders placed on them to manufacture farm equipment to be promoted.
33. A mechanism should be put in place to collect and document information, annually, about the production and sale of different types of agricultural machinery, on the pattern on which crop production and yield data are being collected. It will help in planning, monitoring and implementation of agricultural mechanization programmes.
34. To give benefit of improved high capacity agricultural machinery to small and marginal farmers, custom services of agricultural machinery by private entrepreneurs should be encouraged and promoted. They should be given incentives and long-term loans on concessional rate of interests.
35. Visits of selected groups of progressive farmers and manufacturers should be organized to other States/countries where they can see the modern farms, manufacturers and use of improved agricultural machinery. Periodically teams 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.

36. There should be programme of human resource development and R&D in agricultural mechanization relevant to each State of the region.
37. The district and divisional agricultural engineering workshops should be modernized to produce and supply good quality equipment and offer training to local artisans to upgrade their skills in repair and maintenance of agricultural equipment.

### 16.8 Institutional Framework

38. 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 Deptt. of Agriculture, Agricultural Engineering, Animal Husbandry, Horticulture, Fisheries, Irrigation, industries, manufacturers of agricultural machinery, leading banks, Agro-Industries Corporation, State Planning Board, ICAR Institute(s) in the region, State Agricultural Universities and progressive farmers. This council should meet twice a year.
39. There is need to create separate Directorate of Agricultural Engineering in each State to plan, execute and monitor mechanization and on-farm PHT work.

### 16.9 Policy Issues

40. To encourage agricultural mechanization on sound footing there should be a State Policy for Agricultural Mechanization.
41. For efficient use of stationary farm power units and equipment, the electricity to the farmers, should be provided at subsidized rates but not free.
42. To encourage the owner of farm machinery 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. should be started at the premium rate of 0.5% or less of the machine value insured.

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