

POTENTIAL OF AGRICULTURAL ENGINEERING & TECHNOLOGY FOR CLIMATE CHANGE MITIGATION AND STRATEGIES FOR PROMOTING SUSTAINABLE AGRICULTURAL DEVELOPMENT IN NEPAL.

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COUNTRY PROFILE 2005/2006

General

Location:	Latitude (26 22' N to 30 27' N) Longitude (80 4' E to 88 12' E)
Climate:	Sub-tropical to temperate
Annual rainfall : Average rainfall	2,000 mm (East) to 1,000 mm (West) 16,00 mm
Rainfall duration:	60-80% in monsoon season
Population Estimates (millions)	25.8 (2006), male : 12.9, Female: 12.9
a) Total rural population	85.8 %
b) Farming population	65.6% (2001)
c) Literacy rate	53.7 (2006)
d) Life expectancy at birth	63.3 (2006)
Total Land Area (sq.km.)	147,181, (~14.7 million ha)
a) Himalayan region	35 %
b) Hilly region	42 %
c) Terai region	23 %

COUNTRY PROFILE 2005/2006 Contd..

Land Holding size		
Average size of farm holding:	0.80 ha	
Average no. of parcels/holding	3.3	
Average parcel size (2006/07)	0.24 ha	
Land Use pattern (000 ha)		
a) Agriculture cultivated land	3091	(21%)
b) Agriculture Uncultivated land	1030	(7%)
c) Forest	4268	(29 %)
d) Shrubland	1560	(10.6%)
e) Grassland and Pasture	1766	(12%)
f) Water	383	(2.6 %)
g) Others	2620	(17.8 %)
Irrigated Land (Million Ha)	1.031 (2005/2006)	33.35%
GDP (Million Rs.) 2006/07	719477	
a) Agriculture Sector		
b) Non-agriculture sector		
Per Capita GDP (2006/07)	US \$ 383	
Per Capita GNP (2006/07)	US \$ 456	

Major Cereals 2005/2006

S.N.	Cereal Crop	Area (000 HA)	Production (000 M.T.)	Productivity (MT/ha)
a.	Rice	1549	4209	2.71
b.	Maize	850	1734	2.04
c.	Wheat	672	1394	2.07
d.	Millet	261	290	1.11
e.	Barley	26	27	1.03
Total		3358	7654	

Cash Crop

Sugarcane	62	2462	39.70
Potato	150	1974	13.16

Others: Oil seeds, Tobacco, Jute, Vegetable, Fruits, Tea, Coffee, Honey

Source: MOA, Agri. Business, Promotion and Statistics Division 2005/2006

Population of Livestock & Other Animals for Cultivation/Transport (in Million, 2004/2005)

a. Cattle	6.99
b. Buffaloes	4.08
c. Sheep	0.82
d. Goat	7.15

Agricultural Power

No. of 2 - & 4 - wheel tractor (2005/06)	34336 *
Animal Power (%)	27.3
Human Power (%)	35.4
Mechanical Power (%)	37.3

* Total number is up to 2005/06 first eight months.

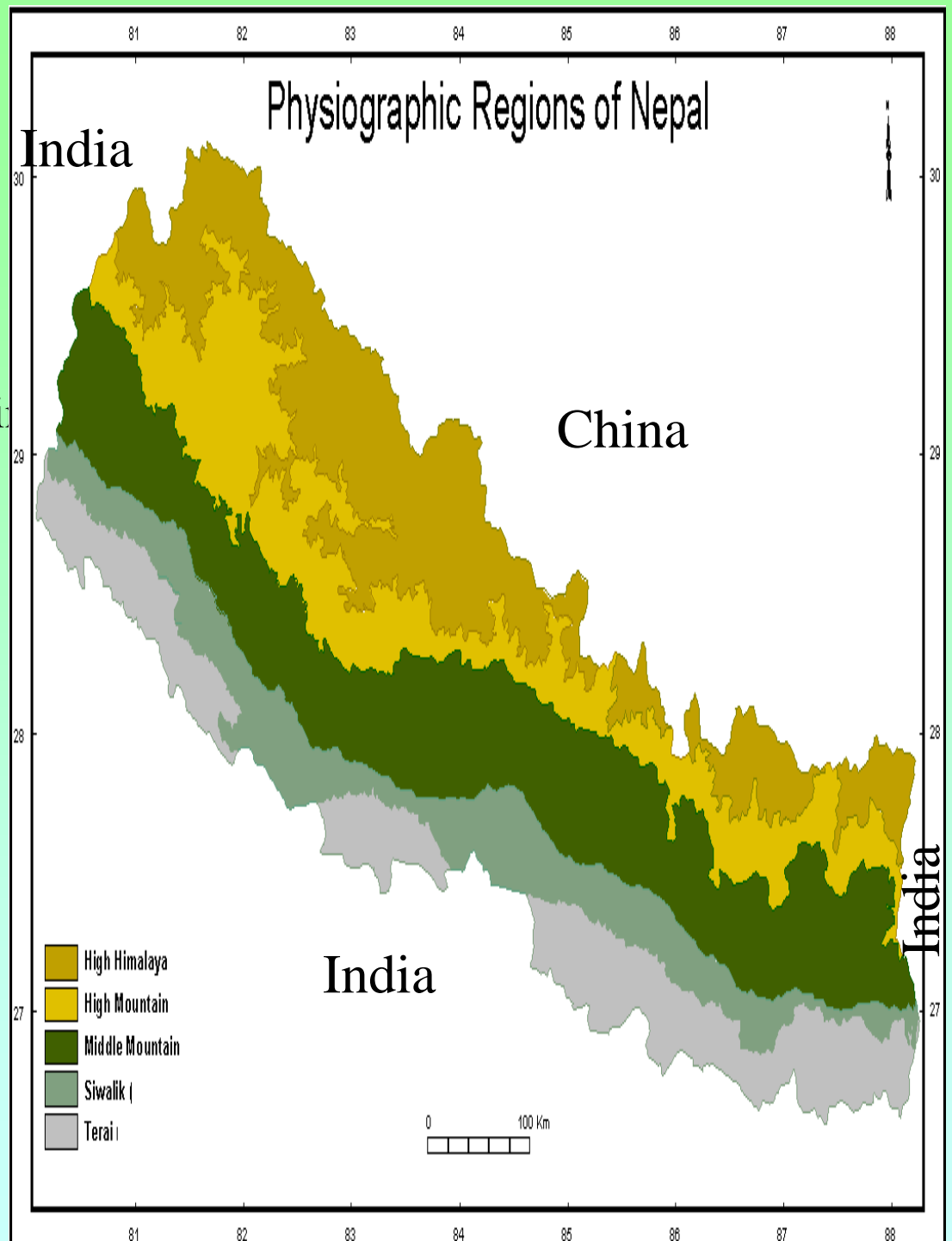
Source : CBS, 2006

INTRODUCTION

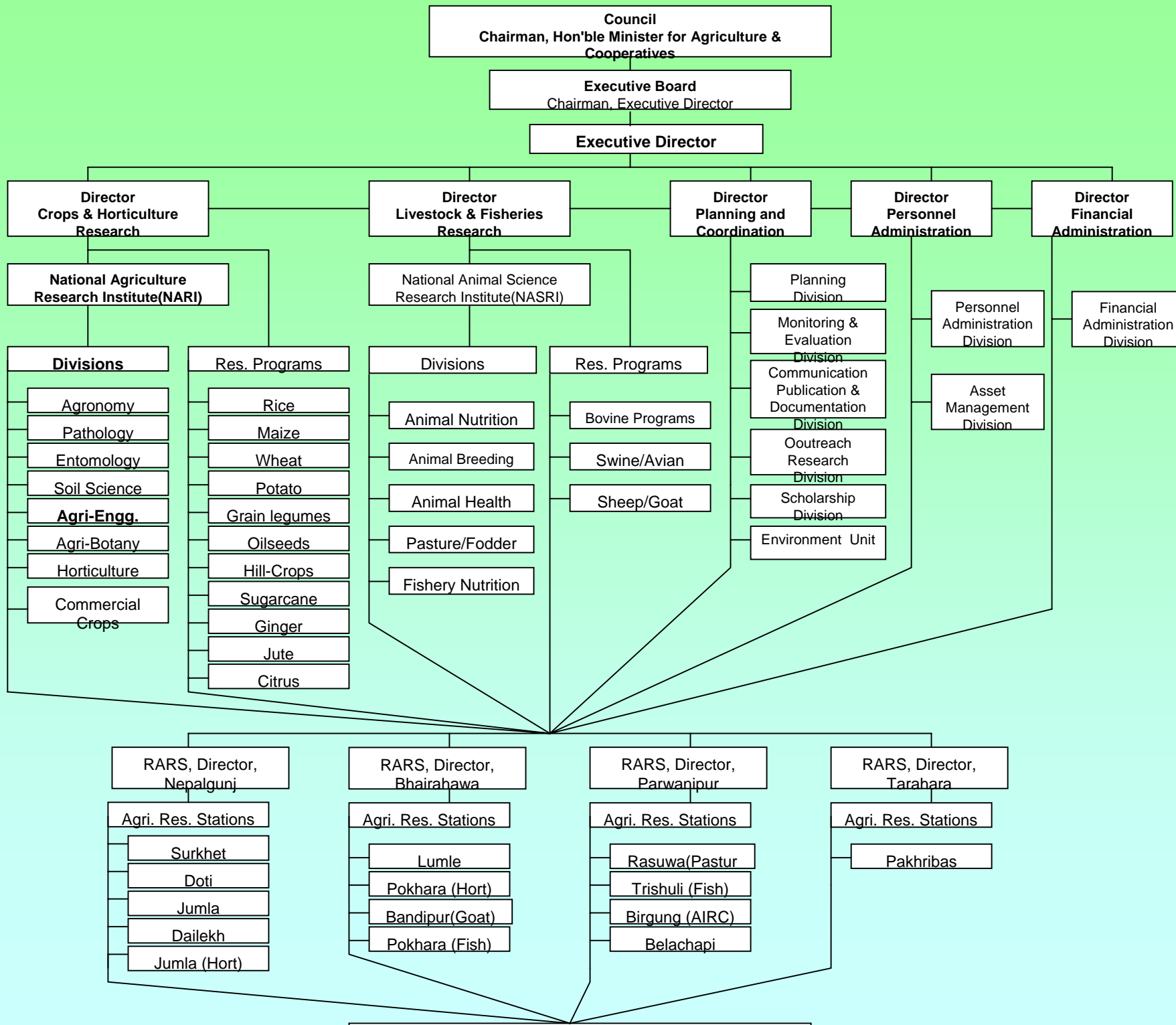
- Nepal is a hilly country with its 65.6% population engaged in agriculture (census 2001)
- Nepal is divided into three regions called the mountain region, hill region and terai the terai region which occupy 35%, 42% and 23% of the total land areas of 147,181 sq.km.
- The elevation of the country rises from 60 meter at Terai (Jhapa) to 8848 meter at Mt. Everest in the north within a short horizontal distance of 90 to 120 km.
- Diverse climatic variation from sub tropical in south to alpine in north .
- Rainfall is the major determining factor for the success or failure of agricultural crops such as rice, maize, wheat, potato and other vegetable as more than 65% of the total arable land is grown under rainfed condition.

Major reasons behind low productivity are

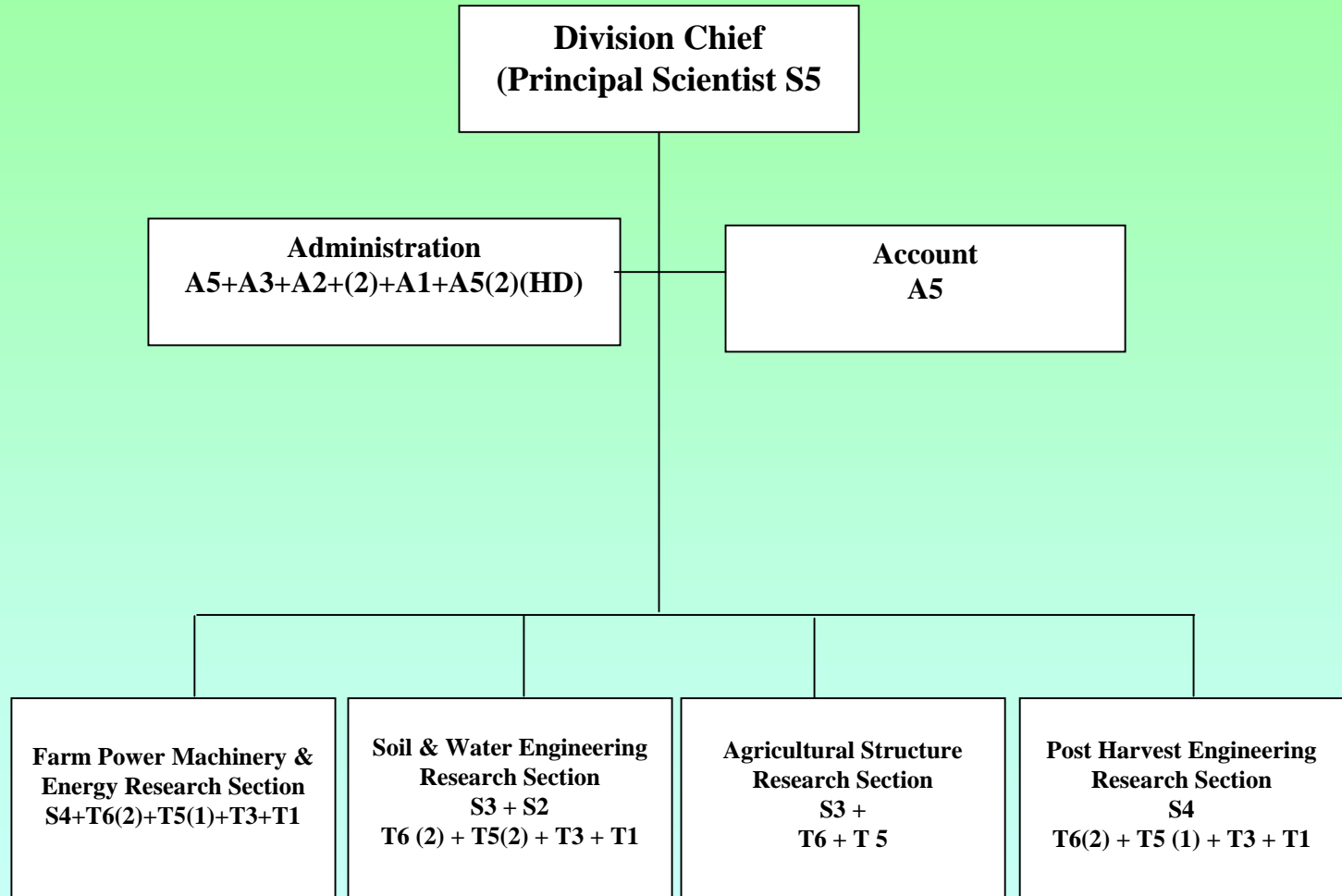
- fragmented small land holdings
- low use of improved seed,
- low fertilizer input with Nitrogen use 17kg/ha only (FAO 2000),
- low use of agricultural machinery and equipment,
- lack of round the year irrigation facility,
- low irrigation efficiency.



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AGRICULTURAL MECHANIZATION SCENARIO

- The status of agricultural mechanization is in its infancy stage.
- Human power followed by animal power are the major sources of farm power in Nepalese agriculture especially in hills.
- The trend of agricultural mechanization is increasing as the use of 2 and 4 wheel tractor is increasing totaling to 34336 (2005/06 first 8 months). In terai land preparation is mostly done by tractors on contract hiring.
- Threshers are used for threshing rice and wheat. Combine harvesters have also been introduced Total estimated mechanical power is only about 0.23 Kw/ha which is 37.3% of total farm power available.

CHALLENGES CONSTRAINTS FOR AGRICULTURAL PRODUCTION

A) Agricultural challenges/issues:

Agricultural Issues

- Small land holdings & Fragmented parcels
- Low agricultural mechanization & High cost of production
- Low fertilizer efficiency
- Overdose of insecticide/pesticide use
- High cost of keeping draft animals
- Poor water management practices
- Under exploitation of ground water in Terai region
- Erratic monsoon
- Soil erosion/losses from the hilly area
- High transportation cost
- Under exploration of renewable energy
- Insufficient utilization of Agricultural waste

Post Harvest Challenges

- High transportation losses
- Lack of packaging techniques
- Low market price of the product value addition needed
- Lack of grain and vegetable dryers

Social Challenges

- Women drudgery
- Shortage of young working manpower in the village
- Migration of young people towards cities.
- Attraction of young people towards foreign jobs.

Environmental Challenges

- Climatic change/global warming
- Increasing soil, air and water pollution
- Over use of pesticides/insecticides in vegetables
- Arsenic problem in ground water in few districts in Terai
- Over mining of ground water in Kathmandu valley
- Under utilization of Agricultural waste
- Under exploration of commodities for bio fuel (Jatrofa and sugarcane)
- Under exploration of commodities for fibers (Banana stem, Ketaki)
- Under exploration of commodities for medicinal plants
- Under exploration of ground water in Terai region
- Lack of promotion of fire wood saving and efficient stoves
- Increasing fuel shortage (non-renewable)
- Under exploration of renewable energy

POLICIES RELATED TO CLIMATE CHANGE

Working policy

1. **Micro & Small Hydro Power:** Electricity generated by Micro Hydro Projects developed by private sectors or communities can be leased out.
2. **Biogas :**
 - 2.1. **Necessary Research** - study will be emphasized for curtailing cost of Domestic Biogas Production Technologies, efficiency enhancement and promotion even in the high hills.
 - 2.2. Biogas Research Development and Extension Community and Organizations will be emphasized.
 - 2.3. Usage of dung cakes as domestic cooking fuels will be discouraged.
3. **Fire-wood, Charcoal, Briquette, Bio-fuel and Biomass Gasification.**
 - 3.1. Scientific management of charcoal production distribution and utilization and its supply systems will be effectively managed.

- 13.2 The possible locations will be identified, development and up scaled for the production of briquettes, bio fuels and biomass gasification on the basis of availability of fire-wood, rice-hull, saw-dist and other agricultural substances.
- 3.3 Emphasis will be led on Research to identify different materials used for briquette production and reduce the production cost.
- 3.4 Programs for enhancing the social awareness will be implemented on the use of local resources for production of briquettes, bio fuels and biomass gasification etc.
- 3.5 Technology on the improved cook stoves and gasification will be developed for the use of minimum fire-wood and thereby minimizing its consumption.
4. Solar Energy : Development of solar energy will be encouraged for drying and cooking foods, heating and purifying electricity and linking up with communication technologies.
5. Wind Energy : Technology transfer activity will be promoted by involving the private sector for the development of wind energy.
6. Improved Cooker Technology: Social awareness will be enhanced for smokeless and firewood saving improved cookers.

Source: Gramin Urja Niti, 2063.

POTENTIAL OF AGRICULTURAL ENGINEERING AND TECHNOLOGY

Nepal is a **country of villages**. Currently there are **3,915 Village Development Committees (VDC)** and **58 Municipalities** in the country. **Most of the villages do not have infrastructure such as rural roads, drinking water facility, electricity, go down and other agricultural structures.** Besides, Nepal is bestowed with natural resources such as snow fed rivers, sloping terraces, forests, long duration of sunshine hours, high rainfall during monsoon etc. The above resources should be harvested economically, without disturbing environment in a sustainable manner for agricultural development. **Agricultural engineers could play very significant role for the development of basic infrastructure in the rural areas.**

OPPORTUNITIES

There are vast opportunities/potentials that can be harvested or explored for building new Nepal.

Opportunities / resources	Possible scope for best harvesting
<ul style="list-style-type: none"> Sloping hills/terraces 	<ul style="list-style-type: none"> Production of off season crops special vegetables. Promotion of gravity rope way transportation of agricultural products (already existing in Dhading districts)
<ul style="list-style-type: none"> Snowfed Rivers / Streams in the hills 	<ul style="list-style-type: none"> Utilize for river transportation wherever feasible Rotary pups, Micro turbines, peltricsets, River transportation (Successful exploration from Melamchi to Bay of Bengal)
<ul style="list-style-type: none"> Sunshine hours 	<ul style="list-style-type: none"> Solar dryers for fruits, vegetables, egg hatchery Cultivation of chaite early rice as it is yielding high
<ul style="list-style-type: none"> High Rainfal 	<ul style="list-style-type: none"> Water harvesting and ground water recharging
<ul style="list-style-type: none"> Under explored ground water potential in Terai region 	<ul style="list-style-type: none"> Further utilization of ground water in potential area in Terai
<ul style="list-style-type: none"> Big neighboring countries 	<ul style="list-style-type: none"> Big scope for exporting off-season agricultural commodities specially vegetables
<ul style="list-style-type: none"> Labour shortage during peak season (transplanting of rice and harvesting of rice and wheat) 	<ul style="list-style-type: none"> Possible expansion of zero tillage seed drill, tran planters, reapers harvesters
<ul style="list-style-type: none"> Zero tillage cultivation awareness among farmers increasing 	<ul style="list-style-type: none"> Possible expansion of zero tillage equipment

<ul style="list-style-type: none"> • Maize crop growing almost the year in Chitwan and Terai 		<ul style="list-style-type: none"> • Good opportunity for machinery manufactures, dealers and workshop operations production of maize planters, ridgers, feed grinders, feed mills
<ul style="list-style-type: none"> • Growing areas under citrus plantation in mid hills • Increasing agricultural waste in the urban areas 		<ul style="list-style-type: none"> • Production of pit makers fruit graders, juice extractor • Production of compost • Recycling of the waste products
<ul style="list-style-type: none"> • Increasing demand of organic product specially vegetable, tea, coffee 		<ul style="list-style-type: none"> • Production and promotion of suitable agricultural equipment, coffee pulper, vegetable dryers • Production and promotion of vermin compost
<ul style="list-style-type: none"> • Increasing demand for cold water fish 		<ul style="list-style-type: none"> • Fish dryers, production and promotion of feed mills
<ul style="list-style-type: none"> • Increasing farmers for milk (cow/buffalo) production 		<ul style="list-style-type: none"> • Production of appropriate grass mowers, hay rake, chaff cutters
<ul style="list-style-type: none"> • Increasing milk holiday 		<ul style="list-style-type: none"> • Value addition of milk product, production of powder milk

INSTITUTIONS INVOLVED IN MITIGATION OF CLIMATE CHANGE EFFECTS

Nepal is experiencing global warming and climate change effect in the following way:

- Rise in temperature has caused change in planting and seeding time, harvesting time in agricultural operations.
- Melting of glaciers - It has caused flooding and landslides.
- Untimely rainfall - It has caused flooding landslides, soil erosion, and damage of agriculture crops.
- High rainfall - It has caused flooding landslides, soil erosion and loss of forest area.
- Low rainfall - It has affected agricultural crops and electricity power generation.
- Drought - It has affected agricultural crops, animal population and natural vegetation. .
- Siltation problem - Due to high rainfall siltation of lake and water reservoirs.
- Rise of river beds causing frequent flooding in terai.

Areas of Work

Agricultural Engineering Division (AED), NARC

AED has focused its research activities in following areas

- Farm power and machinery
- On farm water management
- Irrigation and drainage engineering
- Post harvest engineering
- Agricultural structures
- Energy in agriculture
- Soil and water conservation engineering

Agricultural Engineering Division was established in 2010 B.S.(1953 A.D) as Agricultural Engineering Unit under the Ministry of Agriculture at Singh Durbar Complex to develop physical infrastructures in agriculture. The unit was later promoted to section and then to Division. After the establishment of Nepal Agricultural Research Council (NARC) in 1991 AD, Agricultural Engineering Division (AED) has been continuously concentrating its effort on research in order to develop appropriate technology in Agricultural Engineering. Agricultural Engineering Division is also a National Institute (NI) and Focal Point of Asian and Pacific Centre for Agricultural Engineering and Machinery (APCAEM).

Agricultural Implement Research Centre, Ranighat, NARC

Agricultural Environment Unit, Khumaltar, NARC

National Rice and Wheat Programmes, NARC

Regional Agricultural Research Stations, NARC

Ministry of Science and Technology

Department of Agriculture

Department of Irrigation

Department of Soil and Water Conservations

Department of Water Induced Disaster Preventions(DWIDP)

Department of Soil Conservation and Watershed Management(DSCWM)

Improved Water Mill Support Programme

The Improved Water Mill Support Programme has been honoured by the prestigious; Ashden Award 2007 in recognition of upgrading **over 2,400** traditional water mills in the Himalayas of Nepal and improving livelihood, for millers and mill users and stemming the rise in diesel mills. The Programme is being implemented in 16 hill districts of Nepal. At local level, the programme activities are implemented through 16 service centres and eight Ghatta Owner's Associations (GDA). By end of June 2007, the programme has helped to **install 7,767 improved water mills** in 16 districts. **Replacement of diesel run mills has occurred after installation of IWM.** Thus, IWM has directly helped to contributed in **reduction of carbon dioxide emissions and hence global warming to some extent.**

Drip Irrigation Technology

IDE, Nepal through research and development has developed easy and low cost drip irrigation technology. It is also known as easy drip irrigation.

More than 5000 farmers have been successful to raise vegetable production and to generate income.

This technology needs less water, effective in area having scarcity of water.

Technology successful in hilly region and north belt of terai region.

Transport Programme

- Practical Action Nepal commenced its transport programme in 1998. It improved and promoted innovative transportation systems such as cable river crossing bridges known as twin gravity rope way for hilly and mountains regions and bicycle ambulance/trailer for the terai region.
- Installed a couple of demonstration ropeways in Marpha and Tukche VDCs of Mustang district for the transportation of apples from orchards to the road heads.
- It reinstalled Janagaon/Bishaltar Ropeway in Benighat VDC, Hadikhola - Chiraudi ropeway in Kalleri VDC of Dhading district, and Torisawara - Bishaltar ropeway in Jori Sawara VDC of Gorkha district with.
- The initial study showed that the **transportation cost of agro based products decreased by at least 50%** after being served by gravity ropeway system.

MEASURES FOR MITIGATION OF CLIMATE CHANGE EFFECT

Measures which are useful for mitigation of climatic change effect are mentioned below:

- Promotion of renewable energy programs (solar energy, wind energy, macro and micro hydro plants, bio gas etc.
- Land leveling for increasing water use efficiency
- Minimum tillage cultivation
- Direct seeding of rice.
- Bed and furrow system of planting
- Sprouted seedling of rice
- Surface seedling of wheat
- Rice seedling broad casting
- Use water saving technologies
- Sprinkler irrigation (macro and micro)
- Drip irrigation
- Treadle pump/rower pumps.
- Water shed management.

- Moisture conservation
- Soil mulching
- Bio mulching
- Plastic mulching rain water harvesting
- Increase use of ground water
- Poly house farming
- Relay cropping (Board casting lentil & berseem in the field before harvesting rice)
- Cultivation of crops having low water requirements (Vegetables specially tomato utilization of agriculture waste for making compost.)
- Increase use of compost Farm yard manure, (increases water holding capacity of the soil).
- Adjustment in cropping pattern by introducing short duration varieties.
- Identification of low water requiring varieties.
- Avoid irrigation at non-critical stages of crops.

- Recycling of waste water for agricultural use.
- Recycling of agro industrial waste water for agricultural use
- Rain water harvesting
- Conservation of seeds and germplasm.
- Promotion of varieties which can tolerate continuous flooding and water stress
- Increasing water use efficiency
- Terrace cultivation with inward slope
- Draining the field at less sensitive stages of crop when there is constant supply of irrigation

STRATEGIES FOR MITIGATION OF CLIMATE CHANGE EFFECT AND SUSTAINABLE AGRICULTURE DEVELOPMENT

Strategies for promoting ecological and sustainable agriculture development are mentioned below:

- Alternate water saving irrigation practices/technologies for agricultural crops specially rice should be upscaled or promoted.
- Waste water reuse for agriculture should be given major focus on research agenda.
- Moisture conservation technologies/practices including plastic mulching should be disseminated specially in the rainfed areas.
- Water harvesting technologies/practices should be upscaled wherever feasible through out the country.
- In the areas where there is low water table, ground water should be explored to its potential and heavy investment on other irrigation structures should be discouraged.

- Zero tillage/minimum tillage cultivation for rice and wheat should be scaled wherever possible and support from related stakeholders would be provided.
- Low cost water lifting devices/technologies should be promoted in the feasible areas.
- Research priorities should be focused for estimation for crop water requirement for various crops and crops having low water requirement should be identified and included in the cropping system specially for areas having scarcity of water for irrigation.
- Research priorities should be given on soil-water nutrient management issues to increase their use efficiency for various crops.
- Activities towards management of urban agricultural waste for converting into agricultural compost should be encouraged with necessary facilities and the successful practice should be replicated in other areas.
- Water saved management technology/practices should be further upscaled.

- Poly house farming should be further disseminated in other feasible areas to save crops from climate change negative effect specially heavy rains and micro size hail stone.
- Forage and fodder cultivation on degraded land should be encouraged.
- Measures towards soil conservation and terrace riser improvement should be encouraged and disseminated.
- Renewable energy technologies specially water mill, micro hydro plant, wind mill, bio gas plants should be further upscaled wherever feasible.
- Environment friendly transport systems including gravity ropeway chargeable battery operated three wheeler (safa temp) should be further promoted.
- Measures towards proper management of rice field should be encouraged towards mitigation of methane gas emission.
- Use of biotic and sulfatic fertilizers should be encouraged. Inclusion of legumes in the cropping system should be focused and upscaled.
- Community forest approach should be further upscale or atleast maintained.

EXCEPTED SUPPORT from APCAEM

Strengthening the APCAEM National Institute

AED, NARC as a APCAEM National Institute is networking among the agricultural engineering related institutes in Nepal to the extent possible. However due to the lack of resources, it could not play active role to the expected level. Hence the support from APCAEM is expected in following areas to strengthen networking activities in the country.

- Technology transfer
- Exchange of commercially available equipment.
- Study visits for planners/scientists/technical officers in regional countries
- Exchange of information and publications
- Establishment of Farm machinery testing center at AED/NARC
- Skill development training for existing man power

Joint Action Research Project Development

APCAEM could play facilitating role in the development of joint action research projects in the participating countries and seeking donors for financial support. Some of the possible areas for the joint action research and development projects are listed below:

Programs to mitigate climate change effect including

- Conservation tillage
- Rainwater harvesting
- Integrated watershed management
- Water saving technologies
- Rural transport in hilly areas including gravity ropeway
- Mechanization of hill agriculture
- Value addition of fruits and vegetable products
- Cottage scale processing of herbs and medicines
- Bi-fuel (Bio ethanol and bio diesel)
- Documentation of indigenous technologies and successful story/cases related to agricultural engineering and technology

RECOMMENDATION AND SUGGESTION

- Conservation tillage program (minimum tillage program) should be upscaled to reduce the cost of cultivation and mitigation environmental pollution trough out the country wherever possible with some incentives for few years.
- Methane gas emission in the country is mainly from the agriculture (rice cultivation and enteric fermentation) Methane gas contributes 15% towards the increase global warming. Proper water management rice field by multiple aeration or drainage should be encouraged to save water and to mitigate methane gas emission.
- Biotic and sulfetic fertilizer should be encouraged for agriculture production.
- Rain water harvesting program should be upscaled through out the country wherever feasible. with some incentives for few years.

- Water saving technologies for irrigation of agricultural crops should be encouraged.
- Transport vehicles run by renewable energy should be encouraged and promoted.
- Technology dissemination program should be targeted in the program of districts development/ extension offices.
- For degraded forestland improvements, amriso or suitable species cultivation should be upscaled to alleviate fodder shortage and poverty reduction. Minimum tillage practices with inoculation and starter fertilizer and lime/palliating is recommended.

Thank You