Challenges of Agricultural Machinery Development in Nepal

1. BACKGROUND:

Agriculture is the backbone of national economy, means of livelihood for majority of population, main source of GDP, income and employment opportunities. It contributes to about 32.6% to national GDP (2007/08) and provides part and full time employment opportunities to 65.6% of its population. Due to continuous fragmentation of land, the land holding/ family across Nepal is found to be less than a hectare at present. Moreover average size of parcel is found to be less than 0.3 ha. Because of unavailability of the other employment opportunities, majority of farmers in the country are compelled to adopt subsistence agriculture. Moreover, due to low investment capacity and lack of infrastructure & market opportunities, majority of farmers are adopting traditional technology in their production system.

Major cereals are rice, maize, wheat and millet of which rice is the main staple food. Sugarcane, oilseeds and potato are categorized as cash crops. Apple, oranges, mango, banana etc are the main fruit crops. Potato, cabbage, cauliflower, beans, tomato, etc. are major vegetables and there is increasing trend of growing vegetables in the areas with road and market facilities. Dairy and poultry have significantly contributed the income generation in the village resulting self-sufficiency in milk and egg production. Rice based cropping system is the dominant cropping system in Terai. Rice- wheat, Rice- fallow, Rice -Wheat- rice, Rice- maize, Rice- oilseed- pulse, Rice- potato, rice-pulse, Rice- vegetable-vegetable, Rice- oilseed etc. are major cropping pattern of Terai.

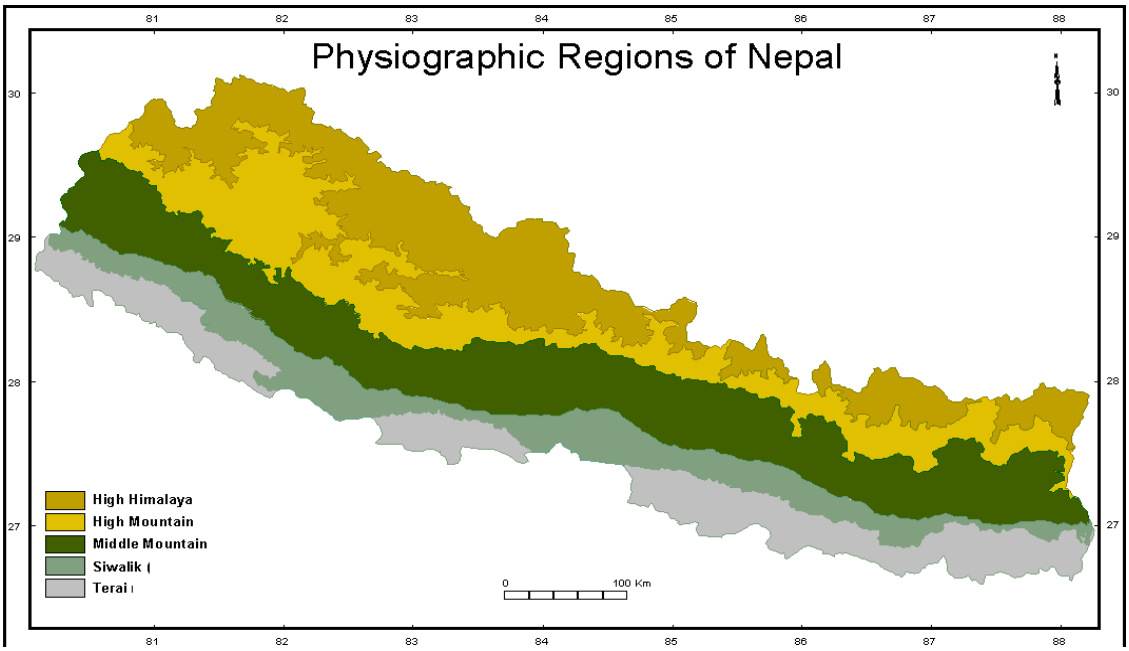
Appropriate agriculture mechanization is a need to achieve timeliness in field operations, increased productivity, to reduce cost of production and to minimize farm drudgery. It also imparts dignity to farm work and makes farming attractive to educated rural youth who otherwise tend to migrate to urban areas in search of job depriving rural sector of their talents and adding to urban congestion and unemployment. Moreover, Nepal has entered into the World Trade Organization (WTO) in 2061 BS which has opened an avenue for the Nepalese farming community towards marketing opportunities of agro-based products in the international arena. So, it has no alternative to lowering the cost of cultivation and reducing the price of agricultural commodities through mechanized commercial farming in order to compete in the world market for the sale of agricultural produce. Mechanized commercial farming will be technically viable and economically feasible only when it is done for commercial-scale production. Commercial agriculture is possible with the consolidated effort of the cooperative farming community, quality input supply on time, developed infrastructure, supportive government policy, proper technical back up, well-established market link etc.

For Nepalese farmers to commercialize their product, production should first be increased above subsistence level. Procurement of various inputs (like seeds, fertilizer, insecticides, pesticides etc.), access to improved technologies including tools, equipment and machinery, marketing through proper channel, access to regional and foreign countries for exporting the agricultural produces, technique of competing with the marketing channel etc. could be the other parameters required by the farmers to achieve commercial farming. Commercial farming means mass production, which is next to impossible without the use of machine for timely operation of agricultural activities. Mechanization helps not only to reduce operational time and women drudgery, but also saves labor and energy. This reduces the cultivation cost creating conducive environment for the competitive market price of the produced agricultural commodities.

2. AGRICULTURAL MECHANIZATION STATUS:

Major hilly regions and many rural Terai areas have no electricity. So, use of manual and animal drawn (AD) implement will be continued for few decades, also due to size & area of land holding. So, rural agriculture needs to be mechanized by using improved hand tools & AD-implement. Hence, hill agriculture needs to be mechanized by using improved hand tools & animal drawn implements.

Fig. 1 Physiographic regions of Nepal



The traditional wooden tools and implements have continued to remain in use in the hills and mountains. There has been some improvement in their design and performance capabilities over time (Pariyar 1991). Due to the lack of physical facilities (viz. road networks and electricity) and narrow terrace cultivation in hilly areas; hill agriculture is mainly depended upon human and animal power. The paddy sheller and polisher and mechanical grinding mills are found to be adopted in majority of villages of terai and hills. However in the mountains, still the milling is found to be performed in local devices such as mortar & pestle, quern and water mills.

Blacksmiths are the primary suppliers of manual and AD-implement for the small and marginal farmers of the country. It is estimated that more than 85% of tools/implement used by the farmers especially in hilly areas are made/repaired by the blacksmiths/rural artisans. So, blacksmiths could play an important role to help in rural mechanization of agriculture in the country.

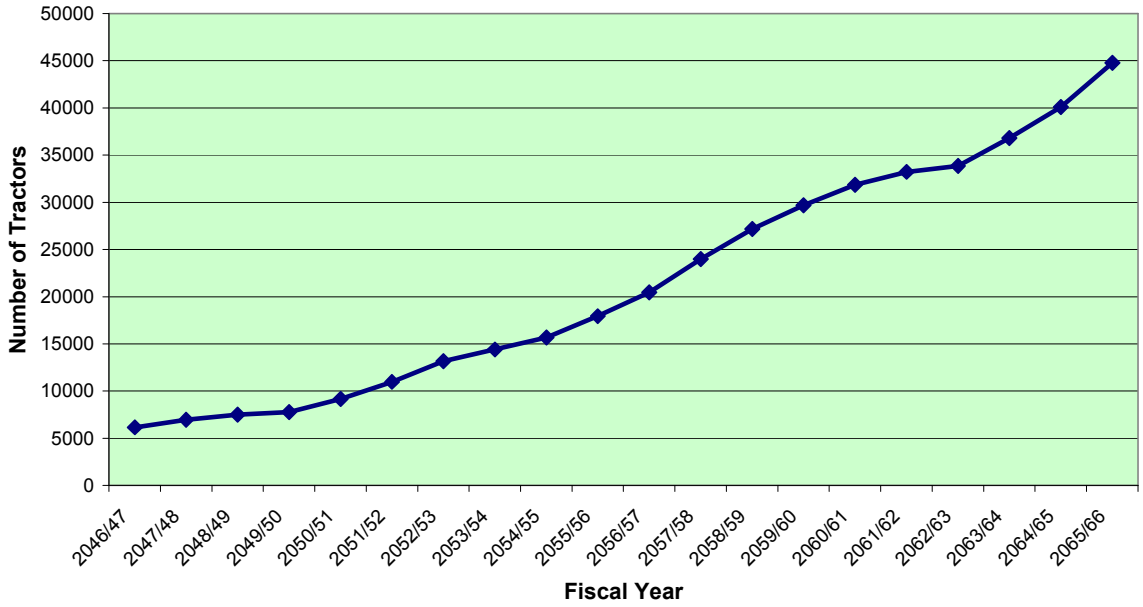
In Terai, along with the traditional farm tools and equipment like, spade, hoe, sickle etc. improved manual tools, e.g. corn sheller, pedal thresher and improved animal drawn implements e.g. mouldboard plough, three- tine cultivators, four-disc and six-disc harrows etc. are being used. The pneumatic-tyred animal carts are rapidly replacing the traditional animal carts. This change is taking place mainly due to the scarcity of wood, and also to increase pulling efficiency of the cart. Animal power is also widely used for threshing through tramping action. Similarly bullock carts with traditional type (wooden wheel) as well as improved type (rubber tyre wheel) is also common in Terai. Diesel pumpsets are also found to be commonly used for pumping water. 4-wheel tractor as well as 2-wheel power tiller is increasingly used for tillage and transportation.

Mechanically powered machines for the farm operations which require high doses of power input but little control e.g. tillage, transport, threshing and lift irrigation are increasing whereas the operations which require relatively little power but a high degree of control, e.g. transplanting, weeding, harvesting, etc. are still performed completely by human labor. Tractors and power-tillers are used for tillage and rural transport and to some extent for threshing. Mechanization of tillage is favored because its cost is considerably lower than animal power sources. Mechanically powered pump-sets are becoming popular since the availability of irrigation water has enabled farmers to intensify cropping and grow up to three crops in a year such as two successive paddy crops followed by a wheat crop.

For about last five years, labour is getting scarce during peak periods and their charge is increasing. From time to time, farmers are complaining on increased cost of production and reduction/unexpected fluctuation of price of certain commodities like rice, wheat, maize etc. So, some innovative farmers have imported few combine harvesters for custom hiring. The user farmers are found to be increasingly interested in adopting combine harvester to reduce cost of harvesting.

Number of tractors being registered with the Department of Transport Management is increasing every year. Total number of four & two wheel tractors registered had reached 44767. 4- wheel tractors in the terai and 2 wheel tractors in the valleys have brought revolution in the tillage operation and there is increasing trend on the adoption of tractors in Nepal and the trend of tractor use in agriculture is given in fig. 2. As an impact of increased demonstration and action research on two wheel tractor (2 WT) by Agricultural Engineering Division (AED) & Agricultural Implement Research Center (AIRC) and lack of human and animal labor in peak cultivation season, there has been quantum jump in 2 WT sale about 850 in last year from 200-400/ year.

Fig. 2: Total Number of Tractors Registered in Nepal



At present 42 percent of cultivated area has irrigation of some sort but only 17 percent of cultivated area has year round irrigation. In Terai out of 889000 ha of irrigated area, 82 percent is provided by surface irrigation and rest 18 percent is provided by ground water (tube wells). (WECS, 2002) The agricultural census reveals that 13.8 percent of holdings in Terai use pumpsets for pumping water mainly from shallow tube well. Most of the pumpsets are diesel engine of 5-10 hp. The use of pump

set to irrigate can result favourable situation for year round irrigation and better control over water application resulting intensive cultivation. Apart from this, more than 80,000 treadle pumps have been installed in Terai for irrigating mainly vegetable crops by small farmers in Terai. Farmers have been using surface water application method resulting high water application losses. More over lack of leveling of irrigated plot is also one of the reasons for low water application efficiency in Terai.

3. SUCCESS STORIES IN AGRICULTURAL MACHINERY/TECHNOLOGY APPLICATION

3.1 Combine harvester:

It is a technology which is introduced with out Government interventions. It is adopted in western and central terai region. There are 9 combine harvesters in operation for harvesting rice and wheat. The cost of harvesting and threshing is reduced to about 50 percent after adoption of this technology. Small plot size and maintenance problems are the major hurdle for the further diffusion of this technology.

3.2 Adoption of Minimum Tillage by Power Tiller Drill:

Traditional wheat sowing is done through broadcasting seed on the prepared surface (mainly by animal power) and manipulating them with soil through tillage operations (ploughing 4 times and planked 5 times). Poor tilth and manual seed broadcasting cause poor plant stand. The minimum tillage by Power Tiller Drills (PTD) has been popular among small to medium scale farmers, as the drills perform three operations e.g. soil tilling, seed sowing, and planking, simultaneously. Minimum Tillage by PTD produced the highest mean grain yield of 3.5 ton/ha compared to 2.9 ton/ha by farmers' Practice. It was found to be the most economical and showed the mean Net Return of 25755 Rs./ha & Farmer's Practice showed the mean Net Return of 18060 Rs/ha. Zero-till Drill for Kidney bean, Peas, Lentil and Wheat produced the mean grain yield of 2925, 9750 (green pods), 1500, and 3725 kg/ha compared to 2350, 8375 (green pods), 900, and 3100 kg/ha by farmer's practice respectively.

Table 1: Influence of Resource Conserving Technologies on Grain and Straw Yields of Wheat at Farmer's Fields

Treatment	Grain Yield at 14% m.c. (kg/ha)			
	2004/05	2005/06	2006/07	Mean
Minimum Tillage by Power Tiller Drill (T_1)	4418	2954	3282	3551
Zero-Tillage by Zero-till Drill (T_2)	3774	1989	3126	2963
Farmer's Practice (T_3)	3752	2248	2904	2968
F- test (Tr.)	0.384 NS	HS	0.2965 NS	-
CV (%)	16.11	14.91	26.27	-
LSD 0.05	907.38	258.8	484.66	-

S=Significant at 5% level; HS= Significant at 1 % level; NS= Not Significant

3.3 Biogas:

Biogas support program(BSP) is one of the successful program in Nepal Till date 189,122 biogas plants are installed and more than 95% of constructed plants are in operation. . Favorable policy with subsidy, private sector partnership, comprehensive quality standards and strong monitoring mechanism are the major pillar of this program. 72 private Biogas Companies have been strengthened,16 Biogas appliances manufacturing workshops are developed by this program. BSP is an ISO 9001:2000 certification holder for its strong quality management system and subsidy administration. Biogas support program has also received fund from carbon trading.

3.4 Treadle Pump:

Treadle pump is easy to operate, fabricated locally, recovers the investment in short duration and costs less.. It can lift water up to 22 ft, can irrigate upto 5-10 kattha and it had been tested in terai region of Nepal during 1993/94. IDE/Nepal is supporting technically for pump fabrication, marketing and installation. To date, 100000 farmers have been benefited by the use of treadle pump in irrigating various crops and have become successful in income generation. Six private companies are fabricating through distributing local dealers.

3.5 Drip Irrigation technology:

IDE/Nepal, through R & D, has developed easy & low cost drip irrigation technology for Nepal. 5000 farmers have been successful to cultivate vegetable and to generate income. As field can be irrigated with less water, it is more affective in areas having water scarcity. It has been very successful in hilly region and north belt of terai region.

3.6 Improved Water Mill (IWM)

Improved Water Mill Support Programme has been honoured by the prestigious London based "Ashden Award 2007" in recognition to upgrading over 2,400 traditional water mills in the Himalayas of Nepal and improving livelihood of millers and mill users and stemming the rise in diesel mills. It is being implemented through 16 service centres and eight Ghatta Owner's Associations (GDA) in 16 hill districts of Nepal. By end of June 2007, it had helped to install 2,767 improved water mills; 2,473 are of short shaft used for efficient grinding and 294 units are of long shaft used for other end uses such as rice mill, saw-mill, oil expeller, lokta beater, chiura making. It has replaced diesel mills directly helping to contribute in reduction of carbon dioxide emissions and hence global warming to some extent.

3.7 Gravity Ropeway

Gravity ropeway technology was transferred from Northern India to Nepal in collaboration with ICIMOD and private manufacturer/supplier. Couple of demonstration ropeways had been installed in Marpha and Tukche VDCs of Mustang district to facilitate apple transportation from orchards to the road heads. Afterwards, it installed Janagaon/Bishaltar ropeway in Benighat VDC, Hadikhola-Chiraudi ropeway in Kalleri VDC of Dhading, and Torisawara-Bishaltar ropeway in Jori Sawara VDC of Gorkha with financial support from the donors. Initial study showed that transportation cost of agro-based products decreased by at least 50% after being served by gravity ropeway system. It provided confidence to the villagers to supply their products (eg. Vegetables, milk and other agri and forest products) in larger amounts, to enter the competitive market in cities. It also improved their socio-economic status and health, education and community awareness. In addition, it created employment opportunities & supporting business of local manufacturers and service providers. There could be many other places where this technology would be applicable.

3.8 Other Agricultural Machineries:

Some agricultural machinery developed by AED, NARC viz. Hand Maize sheller, Coffee pulper, Millet thresher cum pearler, low cost solar dryers are commercialized and adopted by the farmers in different parts of Nepal. Hand maize sheller is used for shelling maize which reduces the drudgery of women farmers in shelling maize. Coffee pulper is adopted in commercial scale pulping of coffee at community level which significantly (more than 50%) increased the capacity and efficiency than the wooden pulper. These coffee pulpers helped the farmers to produce quality coffee parchment efficiently. Similarly for the millet farmers who are at present threshing and pearling millet manually has got an option for efficient threshing and pearling as well as reduction of drudgery. For the remote areas where other types of commercial solar dryers are costly and difficult to maintain, the low-cost solar dryer is developed and promoted by AED.

4. ISSUES & CONSTRAINTS OF AGRICULTURAL MECHANIZATION :

4.1 Socioeconomic Issues:

4.1.1 Lack of Alternative Employment Opportunities

Poor situation in industrialization and development of service sector has resulted very little employment opportunities in the sectors other than agriculture. The present increasing trend of young people going abroad as a labour is still a debatable issue on its contribution in the national development in long run. In this context creation of local employment opportunities in other sector viz. industries & service sector will create a favorable situation for agricultural mechanization in the country.

4.1.2 Small and fragmented land holding

Small and fragmented land holding has been one of the major constraints in slow pace on adoption of agricultural mechanization in Nepal. As about 50 % of the holdings is having land area below 0.5 ha, the mechanization program and policy should address the farmers of all categories; specially small and medium land holding size.

4.1.3 Declining Sharing of family labour

The customs of sharing family labour in the labour intensive agricultural operations like transplanting and harvesting is found to be declining in the rural areas. The farmers reported that there is lack of labour in the peak agricultural labour demanding season. Due to lack of employment opportunities in the country, huge numbers of young people are going abroad to Malyasia and Gulf to work as a labour. Hence, the agricultural operation is found to be completely dependent upon the old and female members of the family.

4.1.4 Poor Conditions of Blacksmiths

The blacksmiths which can play important role in agricultural mechanization through fabrication of agricultural tools and implements are the deprived group in the community and their indigenous skill and technology is at the verge of extinction from the community, due to lack of commercialisation and modernization of their skills as well as lack of recognition of their contribution by the community and the state.

4.1.5 Gender Concerns

Except tillage and marketing activities in the crop production activities, in all farm activities, women farmer (labour's) contribution is found to be ranging from 40 percent to 64 percent. This share is even found to be increased due to out flux of male members of household to urban area and even abroad in search of job. The contribution of women in farming operation is rarely recognised and their drudgery on farm operation is not addressed. Major agricultural operations related to women's drudgery in Nepal are rice transplanting, weeding, harvesting, transportation , milling etc. Even though the constitution of Nepal has declared illegal to discriminate the women, the wage rate of agricultural women labour in villages is found to be only about 50 percent to that of male labour.

4.1.6 Capital Constraints

Agriculture in Nepal is dominated by subsistence level of farming communities. It is mainly due to lack of capital, technology and market. Even though, there is extension of credit institutions in Nepal, the interest rates are found to be more in rural sector than in urban sector (viz. housing loan, car loans etc.). Many co-operatives and micro credit institutions have been evolved in the villages of Terai, they need awareness and model projects on co-operative farming for intensification and commercialization of agriculture with appropriate mechanization.

4.2 Technological Issues & Constraints

4.2.1 Need of agricultural mechanization for small-holders:

As the farm holding size and socio-economic background of Nepal is diverse and is mainly dominated by small farmers and poor farmers, the mechanization need to be focused on appropriate mechanization technologies addressing the needs of different category of farmers in terai , hill and mountain. Hence the agricultural mechanization program should not be limited to promote increased use of tractor but also include improved manual tools; animal drawn implements and appropriate mechanical machinery in Terai. As the majority of the farm operation is performed by women, the tools and machinery are to be promoted by catering the needs of women farmers. The research and development on farmer friendly appropriate tools and machinery is also needed to be reoriented addressing gender concerns.

4.2.2 Availability of spare parts:

From the perspective of the farmers, the major technological constraints are difficulty in availability of spare parts, lack of training on operation and maintenance of farm machinery, inadequate facility for servicing and repair of farm machinery. At present, Nepal has to dependent on the imported tractor, power tiller and other farm machinery and the dealers and traders are not financially strong enough to stock all necessary spare parts. Hence the farmers have to wait for months to get the necessary spare parts. Moreover the cost of spare parts is also reported to be high.

4.2.3 Poor condition of local agricultural machinery fabricators:

Blacksmiths used to play an important role in producing and repairing hand tools and bullock drawn implements. It was estimated that more than 85 percent of hand tools and implements are made by local blacksmiths (Manandhar 1999). Due to poor economic background, lack of modernization in their technology, social system, poor education level these blacksmiths could not commercialize their skills of manufacturing agri tools and implements in the community. Enhancing the capacity of those blacksmiths through capital support, manufacturing facility upgrading, training (fabricating and repair and maintenance skill on improved agricultural machinery and entrepreneurship) etc. not only uplift the deprived section of the society but also contribute the community by supplying improved agricultural tools & implements and providing repair and maintenance facilities locally.

4.2.4 Lack of technical and safety standards

There have been no standards adopted in production and import of agricultural machinery in Nepal. There have been several accidents during use of agricultural machinery. Hence there is need of enforcing safety standards on agricultural machinery production and import.

4.3 Policy Issues

4.3.1 Lack of agricultural mechanization policy:

Due to lack of clear-cut policy on agricultural mechanization, the agricultural mechanization is not found to be streamlined as per the need of the farming communities and national development goals on commercialization of agriculture in Nepal. Hence there is need of clear-cut policy on agricultural mechanization and other related policy is also needed to be amended accordingly. The policy should guide for the amendment of existing unfavorable legislation and enforce favorable legislation measures; strengthen institutional setup for promotion of agricultural mechanization; focus on implementation of appropriate agril mechanization programs and projects with priority.

4.3.2 Lack of Recognition of Farm Machinery Custom Hiring Enterprise

It is evident from the land size distribution and economy of the village that each household cannot purchase full set of farm machinery for its own use. The most of the farm machinery owners in Terai, first they use in their own field after that they rent out those machineries to others. More holdings are found to be served by the tractors, threshers, sprayer & pump set. Custom hiring of farm machinery is taking place in an informal way in each village without any support from government. To improve the profitability from each agricultural machine, the operation hours is to be increased. These custom-hiring enterprises could play an important role on introduction of improved farm machinery and spread the benefit to the farmers in the community. Hence, government should recognize this custom hiring enterprise and support through training and credit.

4.4 Institutional Constraints

4.4.1 Poor Ag. Machinery Extension System:

Even though, Department of Agriculture has network of dissemination of improved agricultural technologies in 75 districts, the agricultural mechanization related technologies disseminated so far are limited to sprayer and metal bins only. It is mainly due to lack of subject matter specialist and needed organizational set-up. Recently the directorate of agricultural engineering is established with limited manpower, but there is not a single agricultural engineer graduate officer at the district level extension offices. Hence for the dissemination of the agricultural engineering technologies there is need of major organizations reform in department of agriculture for the promotion of appropriate mechanization in Nepal.

4.4.2 Poor Ag. Machinery Research System:

Similarly under NARC, Regional Agricultural Research Stations and Majority Commodity Programs there is lack of posts for Agricultural Engineering Researchers (scientists) for farm power machinery research. Hence in the case of NARC, the institutional reform works needs to be carried out by reviewing the distribution of agricultural engineering researcher in AED, AIRC, RARS and commodity programs, creating specific faculty of farm power and machinery research, establishment of agricultural machinery and implements testing/ research centers at eastern and mid/ far western region. Physical facilities for farm power machinery research under NARC viz. laboratories/ workshops and testing centers needs to be established.

4.4.3 Lack of Awareness of Improved Ag. Machinery:

From the recent survey, it is revealed that farmer in Nepal lack awareness on improved agricultural machinery and adequate know-how on the operation and maintenance of improved agricultural machinery, there is urgent need training programs for the farmers in Nepal. However, there is no institution providing organised regular training on operation and maintenance of improved agricultural machinery.

4.4.4 Lack of Institution for testing and quality control of Ag. Machinery;

There is no institution to undertake machinery testing, quality control and standardization. Even though, Department of Nepal Bureau of Standards and Metrology provides Nepal Standard of different products produced in Nepal, till now it has not made any standard on agricultural machinery. For testing and certification to meet the specified performance and quality and safety standards of locally manufactured as well as imported farm machinery, there is need of an institution in the country.

5. PRIORITY AREA FOR TECHNICAL CO-OPERATION

5.1 Strengthening National Institute of APCAEM

Strengthening the 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

5.2 Joint Action Research Project Development

APCAEM could play facilitating role in the development of joint action research regional 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
- Conservation tillage
- Rainwater harvesting
- Water saving technologies
- Mechanization of hill agriculture
- Value addition of fruits and vegetable products
- Cottage scale processing of herbs and medicines
- Development of safety standard for agricultural machinery
- Documentation of indigenous technologies and successful story/cases related to agricultural engineering and technology

6. RECOMMENDATIONS FOR ESTABLISHING AN EFFECTIVE MECHANISM TO PROMOTE AGRICULTURAL TECHNOLOGY TRANSFER

6.1 Strengthening R & D Institutes

Research and development of appropriate agricultural machinery is crucial for appropriate agricultural mechanization promotion in the country like Nepal where there is diverse agro ecological situation and dominated by small holders. The research and development of institutes related to agricultural machinery in Nepal are to be strengthened with respect to human resource, facilities and infrastructure.

6.2 Establishment of Standardization and Certification Institute

Since there is no agricultural machinery testing, standardization and certification institute, there is need of establishing an institute responsible for standardization and certification of agricultural machinery. At present the testing centre could be established at agricultural implement research centre, Ranighat. There is also need for legal measures for standardizations and certification.

6.3 Supporting for Local Fabricators of Agricultural Machinery

Role of local fabricators and blacksmiths is crucial for agricultural mechanization promotion in Nepal. Technical support and other support are needed to strengthen these fabricators and blacksmiths. R & D institutes and local fabricators need to work together for the promotion of agricultural mechanization in the country.

6.4 Establishment of Network of institutions including private sector involved with agricultural machinery

There is need to establish a network of agricultural machinery related institutions viz. research, training, extension, importers, traders, dealers, fabricators, financial intermediaries, policy makers, universities etc. This network will share their experiences and open platform for collective actions for the promotion of appropriate agricultural mechanization in Nepal. More over this network can also press the government and policy maker for the favorable policy for appropriate agricultural mechanization.

6.5 Collaboration with national and international institutions for technology transfer

There is also need for the national, bilateral and multilateral collaboration of institutes related to agricultural mechanization for sharing the experiences and the technologies in their respective countries. This will also help for the exchange of prototypes and experts across the countries. Joint projects could also be formulated to address common problems of the region itself.

6.6 Policy support for Promotion of agricultural mechanization

Favorable policy is the critical for the promotion of agricultural mechanization in the country. All the different policy viz. agricultural, industrial, labour, energy, export/import etc. are needed to be streamlined for promotion of agricultural mechanization. Policy support is also needed for following areas for promotion of agricultural mechanization in Nepal.

- Co-operative farming and land consolidation for agricultural activity
- Contract hiring of agricultural machinery
- Support for agricultural machinery manufacturers
- Standardization and safety of agricultural machinery
- Promotion for energy efficient machinery
- Promotion for conservation farming related machinery and green technologies
- Promotion for value addition and employment generation related small and medium scale agro industries

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