Mandal S. M.A., S.D. Biggs, S.E. Justice, (Eds).2017. Rural Mechanisation. A Driver in Agricultural Change and Rural Development. Institute for Inclusive Finance and Development (InM), Dhaka, Bangladesh, xp276.

Chapter 4

Agricultural and Rural Mechanisation in Nepal: Status, Issues and Options for Future

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Introduction

Nepal is a small land-locked mountainous country with diverse agroecologies, culture and agriculture. Agriculture is a key source of economic growth, poverty reduction and environmental sustainability in Nepal. It is the mainstay of the national economy, contributing one third of GDP and providing livelihood to more than two thirds of the population (MoF, 2013). The poverty rate is declining over the last two decades but it is still high with one-quarter of its population (25.1%) living below poverty line (CBS, 2012). Food crops are the major components accounting for about 40% of AGDP, while livestock and fishery account for 30%, horticulture and cash crops 20%, and forestry about 10% (MoF, 2013).

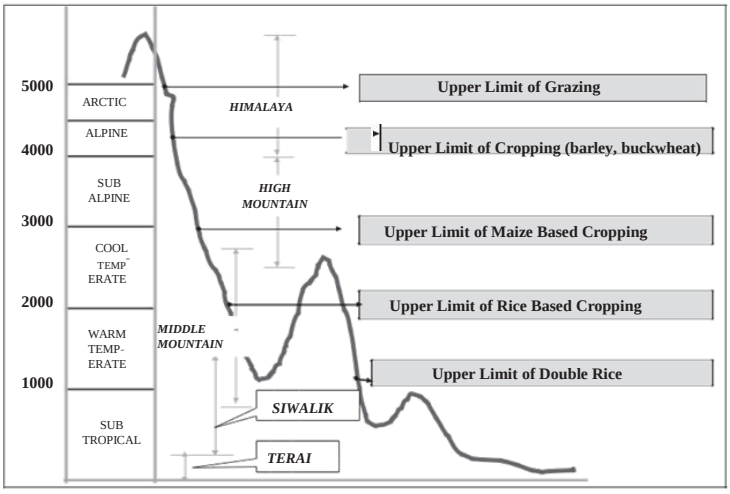
Agroecologies and Farming Systems

The country is divided into three primary ecological zones mainly running east to west: (i) the mountain region bordering Tibet of China covering high Himalaya and high mountains, (ii) the Hill region in the middle, and (iii) the Terai or plains covering inner (siwalik) and main Terai bordering India. The Mountain, Hills and Terai, respectively, covers 35%, 42%, and 23% of the total land area of the country (CBS, 2012). Each of the three main ecological zones has its own unique resource endowments, cropping patterns and farming systems leading to differences in commodities produced, production levels, and productivity. There is also a high socioeconomic diversity: with more than 100 ethnic groups with different culture, communities and economic conditions (large absentee landlords to landless tenant farmers) with diverse needs for farm machinery and equipments.

A high agroecological diversity exists in Nepal ranging from flat lowlands and rivers basin to rugged mid hills and steep mountain slopes with subtropical to

warm temperate, cool temperate, and alpine to arctic type climates (Figure 1). As a result, there is a diversity and complexity of farming systems with adaptation to specific crops and commodities in specific altitudinal zones. Rice based farming system is predominant in Terai, inner Terai and lower part of mid hills, while maize based system is predominant in middle hill to lower part of high mountain region. In rice based system, double cropping of rice is only possible in subtropics below 1,000 msl in Terai and Siwalik (inner Terai), while single rice cropping is possible until 2,000 msl[1] in middle mountains where warm temperate climate is prevalent. The mountain crops such as buckwheat and naked barley is grown in high mountain region up to 4,500 msl, where climate is subalpine and alpine type. Pastoral production system with livestock grazing is possible in arctic climate upto altitudinal range of 5000 msl. Crop-livestock and forestry integration is the characteristic features in all these systems.

Figure 1
Diversity of Agroecological Zones and Farming Systems in Nepal



Agrarian Structure

The agrarian structures of the country are characterised by a very small land holdings scattered to different plots, where irrigation availability is very limited and seasonal. The average size of land owned by the household currently in Nepal is about 0.68 ha, which is highly fragmented, averaging 3.1 parcels with

[1] Exception exists in Karnali region, where rice is grown upto 3,000 msl in Chumchur of Jumla district.

average size of 0.21 ha per parcel (CBS, 2013). At present, about half (52%) of the farm households own less than 0.50 ha land with low farm labour productivity, and low level of intensification. Area under farming is declining over the years as a result of conversion of prime agricultural land into non-agricultural uses (e.g. housing, industries and infrastructure development) through rapid urbanisation and rural-urban migration. Hence, in the last 10 years, net cultivated area has declined by 5% from 2.65 million ha in 2001 to 2.52 ha million in 2010 (CBS, 2013). Average farm size has also declined over the years from 1.11 ha in 1961/62 to 0.68 ha in 2011/12. The number of households with 2 ha or more of land has decreased from 12 percent in 1995/96 to 4 percent in 2010/11. Moreover, two thirds of the cultivated area is rainfed, where agricultural production is risk-prone and marginal. A large proportion of farm households (30%) are employed only partially. About 60% of the households in Nepal have only six months of food sufficiency from their own production. Population density on cultivated land is high where more than 10 people are dependent on a hectare of land for their livelihood. Agricultural productivity and profitability from farming are low due to low use of modern and mechanised technologies, high cost of production, limited commercialisation and diversification of agriculture. Labour scarcity is chronic in agriculture as a result of massive youth migration from rural areas.

Importance of Agricultural Mechanisation for Nepal

Agricultural mechanisation is being recently realised by policy makers and planners as one of the potential options for addressing agricultural labour scarcity, high cost of production and promoting commercialisation in agriculture. Mechanisation is also an option for improving efficiency in agriculture production, reducing women drudgery and promoting diversification in agriculture. Mechanisation saves costs and resources (labour, energy) by reducing operational time in agriculture and improving timely farm operation. It helps make agriculture competitive in the region by reducing the cultivation cost, improving quality of the products and creating conducive environment for the competitive market price of the produced agricultural commodities. The rationale for mechanisation in agricultural development is to increase the scale of farming operations and to improve the timeliness, quality, and efficiency of the operations for increase production, productivity and profitability of farming operation. Mechanisation, therefore, can contribute to increasing production, productivity, and profitability of agriculture by increasing land and labour productivity as envisaged in

Agriculture Perspective Plan (1995-2015) and newly formulated Agriculture Development Strategy (2014) of the Government of Nepal.

Evolution of Agriculture Mechanisation

The history of institutional development for formal sector farm mechanisation dates back with the establishment of Agricultural Implement Research Unit at Birganj in 1960 (MoAD, 2014). Since early 1960s, private sector played important role in farm mechanisation with the import of four- wheel tractors (4WTs) for agricultural production and transport in the Terai (Pudasaini, 1976). Since 1970s, mechanisation picture has changed significantly with the spread and use of threshers (in wheat and rice) and diesel pumps in farm irrigation. Two-wheel tractors (2WTs) were promoted during the mid-1970s and early 1980s, with two Japanese aid programmes importing approximately 2,000 tractors (Pariyar *et al.*, 2001). Initially, the spread of 2WTs was limited to the Kathmandu and Pokhara Valleys, where they were used for transport and tillage (Biggs *et al.*, 2011). Tractors are common in tillage and transportation of agricultural products, while combine harvesters are increasing being used in harvesting. From the mid 1990s onwards, large Indian combine harvesters were seen in Nepal, and today about 200 Nepali combine owners work on a contract basis in various districts in the Terai, majority of which are concentrated in Rupandehi, Bara, Parsa, Rautahat, Kapilvastu and Kailali districts. Mechanisation technologies and machines available across the long open border with India greatly influenced mechanisation patterns in the Nepal Terai (Biggs *et al.,* 2011; Justice and Biggs, 2013). With increasing road connectivity in rural hills and mountains, use of tractors, power tillers, pumpsets and threshers is increasing in rural hills and mountains as well. At present, the most widely used farm machineries are threshers and small scale irrigation pumps that are becoming popular in most parts of the Terai and market accessible hills because farmers see a clear advantage of using machineries in terms of saving time, resources, and labour. In addition, mechanical equipments are increasingly being used in the rapidly growing horticultural, poultry, dairy and animal feed industries and other "value added chains", mainly through private sector initiatives based on agricultural and other rural resources.

Status of Agriculture Mechanisation

Use of farm mechanisation is currently very low in Nepal. Official statistics show that animal and human power are still major sources of power used in

agriculture, which constitute about 41% and 36%, respectively. Use of machine power is estimated to be only about one –fifth of the power used in Nepal (AED, 2013; Shrestha, 2012). About 90% of the currently used mechanical power is concentrated in market accessible Terai. In the hills and mountain districts, mechanisation is low given the difficulties of transporting heavy machinery and using it on small terraces. However, with increasing road connectivity in rural hills and mountains, use of tractors, power tillers, pumpsets and threshers is increasing in recent years. In the last five decades, some progress has been made in agricultural mechanisation in Nepal with various types of machinery being adopted, primarily through imports by the private sector and its engagement with farmers. These include several power-operated agricultural machines including the following: water pumps; tractors both 4 wheel and 2 wheel; harrows; rotavators; seed drills; threshers; combine harvesters; agricultural processing machines; rice, oil, and pulse mills; and laser land-levelers particularly in Nepal Terai (Biggs and Justice, 2013).

The data of national sample census in agriculture revealed that most common agricultural machinery used in agriculture includes iron ploughs, tractors and power tillers, thresher, pumping sets, sprayers, shallow tube wells, etc. (Table 1). Animal drawn carts, and treadle pumps (*Dhiki*) are also in operation in Terai. As per the recent national census in agriculture (CBS 2013), the percentage of households using iron ploughs, tractors and power tillers, thresher, pumping sets and shallow tube wells constitute about 28%, 24%, 21%, 14 %, and 9%, respectively. In Nepal, mechanised equipment has also spread, but this does not appear to be so focused on rural poverty reduction, rural employment and productivity increasing (Justice and Biggs, 2013).

In Nepal, about 76 thousand four-wheel tractors are registered till 2011. It is estimated that about 22,000 power tillers and about 5,000 mini tillers are in operation in Nepal (AED, 2011). But not all of these are used in agriculture. It is estimated that about 30 % of the registered tractors and above 80% of registered power tillers and 100 % mini tillers are actually used in agriculture. A large proportion of tractors are used in non -agricultural purposes, including use in rural transport, construction, sand mining and quarrying industries. According to 2010 estimates, there are 120,000 pump sets, 190,000 threshers, 10,000 mills 190,000 threshers, and 40,000 hand cranked winnowing fans (MoAD, 2012). A most recent estimate shows that there are about 200 combined harvesters operated in Nepal Terai. Similarly, in the livestock sector, commercial dairy farming has increased with increase in use

of machinery in milking, storage, cooling and processing technologies associated with dairy. Information also shows that there are more than 200 thousand biogas plants being operated resulting in increased rural energy use in agriculture. Recently two- wheel tractors are increasingly being popular in Nepal particularly in the market accessible hills and mountains with the increased road connectivity and labour shortage. In the Terai region also there is increase in the use of two-wheel Chinese tractors apart from existing use of four-wheel ones, mostly Indian tractors. Similarly, mini tillers have also increased owing to their compatibility to small land holding size, especially in the hills. The trend of mechanisation is apparent and will be helpful to lift agricultural productivity in several regions of Nepal.

Table 1
Households Using Different Types of Agricultural Machineries in Nepal

Machinery/ Equipments Used	No. of Households	Households (%)
Iron ploughs	1,073,441	28.02
Tractor & Power tillers	920,371	24.03
Thresher	803,154	20.96
Pumping sets	548,203	14.31
Sprayers	574,014	14.98
Shallow tube wells	367,744	9.56
Deep tube wells	159,725	4.17
Treadle pump (Dhiki)	79,145	2.06
Animal drawn cart	334,978	8.74
Other Equipments	290,084	7.57

Source : (CBS, 2013).

Drivers of Agricultural Mechanisation

Mechanisation in Nepal in the past is often influenced by not only as a result of government and donor support policies but also because of the long open border with India, where 4WTs and combined harvesters were being promoted as the symbol of a modern, commercial and efficient agriculture (Justice and Biggs, 2013). The major drivers of agricultural mechanisation in recent years are labour scarcity, high cost of production and increased focus on market oriented farming system including demographic shift and socioeconomic and policy changes in the country. It is triggered by easy

availability and access of farm machinery in the market (low cost Chinese hand tractors, and pump sets, etc.) with commercialisation of agriculture and scarcity of labour for crop production and raising animals with rising animal fodder scarcity. In addition, liberal import policy for tractors and farm machinery and spill-over effect from neighbouring long-open border of India (Bihar, UP, WB) as a result of increasing emphasis on mechanisation in bordering regions of India have promoted use of farm machinery in bordering Terai and market accessible hills. Nepal's historical, cultural and even political connections along with a long and open border with India have led to different patterns for investments in agricultural mechanisation, whether it is farmers' buying machinery, establishing import and export businesses, or local manufacturing capability (Biggs and Justice, 2013).

Agricultural wage rate has more than doubled in less than one decade as a result of labour scarcity and increasing opportunity cost of labour in other sectors. This has stimulated the increasing use of agricultural machinery to substitute human and animal labour and reduce cost. Low tariff rate for the import of tractors and increasing access and availability of farm machinery in the market, such as 2WTs and 4WTs including enabling environment for the promotion of machinery and rural energy technologies in recent years has promoted mechanisation. This is evident by the most recent increasing use of combined harvesters for rice and wheat harvesting in Terai. Furthermore, recently some government R&D programmes are promoting agricultural machineries and technologies, such as zero and minimum tillage and other Resource Conservation Technologies (RCTs).

Policy Context on Agricultural and Rural Mechanisation

Mechanisation was often misunderstood in the past as use of large four-wheel tractors rather than encompassing whole sets of manually operated, animal drawn equipments and smaller machines (two-wheel tractors, pump sets, etc.). The past policies, such as Land Act (1964) focused on individual rights to land, land ceiling and land reform but not on commercial use of agriculture land and its productivity improvement. National Civil Code (1853;1962) also focused on land inheritance and individual rights to land rather than productivity improvement. Nepalese labour policy also has not adequately recognised the value of agricultural labour and its welfare aspects, such as drudgery reduction. Therefore, these policies mainly focused on individual property rights and

equity which encouraged land fragmentation with the provisions of land inheritance and land ceiling resulting in disincentives for mechanisations. The major agricultural development policies and programmes formulated in the last decades, such as Agriculture Perspective Plan (1995-2015) and National Agricultural Policy (2004) also ignored mechanisation due to fear of labour displacement by the use of larger power operated machines (mainly tractor). The context of agrarian structure, (small farm size, fragmented land holding), geographical constraints of rugged topography and narrow terraces in Hills and Mountains and poor understanding of the role of rural and farm equipments other than large tractors also discouraged formulation of policies and programmes for adoption, use and promotion of machineries.

Recently, there is an increasing realisation of agricultural mechanisation among planners and policy makers in Nepal. With the economic liberalisation and need of agricultural development, government of Nepal since late 1990s opted liberal economic policies and encouraged import of agricultural machinery particularly tractors with the import tax exemption focusing on farmers. Most recently, Government of Nepal has formulated and approved "Agriculture Mechanisation Promotion Policy (2014)" to promote agricultural mechanisation and commercialisation in agriculture. Government of Nepal also has recently formulated Agriculture Development Strategy (ADS) which has also strongly recognised the need for promotion of agricultural mechanisation for the commercialisation and development of competitive agriculture. In addition, Government has very liberal import policies mainly tax exemption for the import of large agricultural machinery particularly tractors. There are many other cross-sectoral policies that have directly or indirectly influenced agricultural mechanisation in Nepal. The important ones are presented below;

Trade Policy

The Trade Policy (2010) is relatively favourable; it favours agricultural machinery with lower import to mechanisation duties (only 1% of import tax) and exemption of value added tax as compared to other machineries. However, the establishment of local agricultural machinery industries is difficult to flourish due to high import duty and value added tax on raw materials. This happens due to difficulty in separating agricultural raw materials with other agricultural machineries.

Energy Policy

Rural Energy Policy (2006) was favourable to mechanisation that uses rural renewable energy technologies. It has provision for providing 50-75% subsidy for the use of rural renewable technologies, such as solar dryer, solar pump, micro-hydro, cold storage facilities and machinery and equipments that are run by renewable and environment friendly energy including low tariff rate for irrigation.

Transport Policy

The existing Transport Policy (2002) is neutral to agricultural and rural mechanisation. There is no specific content and provision for promotion or restriction of the mechanisation. However, there is low renewal tax for agricultural machineries as compared to commercial vehicles, indicating that it is slightly fabourable to agricultural mechanisation.

Credit Policy

Credit sector has recently made priority on agricultural sector including mechanisation. Government of Nepal in the budget speech of 2014/15 made special credit interest rate subsidy to 6% from 10% of the current lending rate of commercial bank. The directive for the implementation of this interest rate subsidy scheme has been developed but most of the formal sector credit institutions (commercial banks) have not reached in rural areas. Moreover, the processing cost for credit is high and access is also not easy particularly for the use of farm machinery and equipments.

Industrial Policy

Industry Policy (2010) also makes emphasis on establishment of agrobased industries in addition to specific focus on overall industrial development. But due to high custom duty on raw materials and value added tax on it, there is little incentive for establishment of agricultural machinery based industries.

Subsidy Policy

The government of Nepal in fiscal year 2014/15 has allotted Nepalese Rs. 9.5 crores fund and initiated implementation of subsidy schemes to farmers for purchase of farm machinery. About 50% subsidy is provided to farmers who make purchase of specific farm machinery and equipments, such as power tillers with cultivators and mini-tillers. The focus of subsidy is on small-scale machinery and their attachments, but the amount of subsidy allocated is

limited to promoting mechanisation to large number of farmers. Moreover, providing limited amount of flat subsidy on agricultural machinery may distort the market and under privileged groups of farmers will have difficulty in accessing government subsidy.

Impacts of Agricultural and Rural Mechanisation

In spite of the dominance of small and fragmented land holdings, physical constraints of rugged topography, lack of emphasis on past policy, agriculture mechanisation is spreading in many parts of Nepal including remote hills and mountains. Agricultural machinery is having a positive impact on smallholders since they are efficient in accomplishing timely farm operations, reducing cost and improving product quality. Small-scale threshers, pump sets, and tillage equipment are now more widely available, less expensive, and suitable for small-holders even in rural hills and mountains with increased road connectivity. Other farm machinery needed for harvesting and irrigation also have shown successful implementation in Terai. Use of farm machinery can reduce cost of production significantly since labour cost alone accounts for about 60-65% of the total cost of rice production in Nepal (Gauchan *et al.*, 2012). Field evidences from some parts of Terai and accessible central hills indicate that use of small-scale machinery has helped reduce women drudgery and improved efficiency in the production. Smallholders can also avoid capital investment as, increasingly, Nepalese machinery owners provide custom hiring of machines, particularly tillage equipments, threshers and combined harvesters (Biggs and Justice, 2013; Joshi *et al.*, 2012, Justice and Biggs, 2013). This trend of mechanisation has been growing over the past years as labour shortages arise. Evidence from Bangladesh indicates that the operation of the machines are highly profitable with higher income and profit from use of power tillers followed by that of power threshers and shallow tube wells, respectively (Hossain *et al.,* 2013). The cost of investment from machinery use is recovered within two years indicating farm mechanisation is an economically more preferred option as compared to conventional manually labour operated farming.

Role of Public and Private Sectors in Agricultural and Rural Mechanisation

Role of Public Sector in Agriculture and Rural Mechanisation

Recently, Ministry of ` (MoAD) has made efforts with private sector support in the formulation of Agricultural mechanisation Promotion Policy (2014),

which is a good step in this direction. The state can speed up the process for implementation of Agro-mechanisation policy that has been approved by the Government of Nepal. The role of state is also to support long-term research and development programmes on agricultural mechanisation, which is participatory and client-oriented so that appropriate farmer-friendly tools, equipment, and machinery could be developed and promoted.

In areas where private sector has no incentives in provisioning services, public sector can take lead to facilitate implementation of mechanisation programmes, such as by linking with occupational caste of Nepal, who are engaged traditionally in rural area on manufacturing agricultural tools and equipments. This will help generate employment and poverty reduction in rural areas by engaging liberated bonded labour (*Haliyas),* particularly blacksmiths in manufacturing agricultural tools and equipment and helping to establish their cooperatives for the sale of such machinery.

Role of Private Sector Participation in Agriculture Mechanisation

Private sectors in Nepal have played an important role in the spread of agricultural and rural mechanisation. Potential exists for mechanisation, especially in powering the agriculture sector with tractors and other tillage equipment, and crop protection and harvesting machines. There are a number of private sectors run engineering workshops/metal craft workshops, mainly concentrated in the Terai; these are also involved in manufacturing as well as providing services for agricultural tools, equipment, and machinery. Some of them are providing critical services, such as repair and maintenance and custom hiring of machinery for small farmers who are not able to purchase machinery. Considering small farm size and hilly terrains, private sector investment is geared towards improvements in the two-wheel tractors. Private sectors can play important role in research on commercial viability and market research for agricultural machinery and equipments (Clarke, 2000). They will continue to play important role with better policy support and capacity building from public sector agencies. Private investment in small scale mechanisation can improve if the state provides an additional incentive in the machinery. At present, however, the machinery-supply industry is still dominated by few actors and is less competitive.

Issues and Concerns

Limited Availability and High Import Tax on Spare parts

Availability of spare part is a huge concern as Nepal imports its tractor, power tiller and other farm machinery and this is due to the weak financial status of both dealers and traders to stock necessary spare parts. A high cost of spare parts for agricultural machinery is the result of high import duty and value added tax (VAT). The heavy duty (15-45%) on importing raw materials for manufacturing has created a disincentive to all local engineering firms to engage in local production and sales of machinery, tools and equipment.

Subsistence Farming, Small and Fragmented Farm Size and Difficult Terrain

Nepalese farming system is mainly rainfed and subsistence oriented; two thirds of cultivated area suffers from inadequate availability of irrigation water. Subsistence farming, small farm size, fragmented land holding and physical constraints of rugged and steep topography and narrow terraces in hills and mountains discouraged use of machineries. Farm sizes are not only small but also fragmented into 3-4 parcels that are dispersed in different locations. Declining farm size with land fragmentation poses a significant challenge for agricultural mechanisation in Nepal. Smaller landholding size reduces the self-sufficiency of farms, and it also reduces incentive for farmers to invest in mechanised agriculture, farming infrastructure and tools due to weak economies of scale.

Technological Issues and Constraints

Farmers currently lack appropriate mechanisation technologies addressing the needs of diverse socioeconomic groups of farmers (women, small farmers), farming systems and agroecological domains. Technologies are needed for conservation farming, high value agriculture, value addition focusing on improved manual tools, animal drawn implements and appropriate mechanical machinery for tillage, intercultural operations, harvesting, post-harvest operations, transportation and processing. As the majority of farm operations are performed by women in rural areas of Nepal as a result of male migration, the tools and machinery currently promoted do not meet the specific needs of women farmers or reduce their drudgery.

Institutional Issues and Constraints

In Nepal, institutions for research, extension and educational programme in agricultural and rural mechanisation are very weak. Current R & D and educational institutions lack adequate resources, expertise and infrastructure facilities in agricultural engineering and technology on mechanisation. NARC Regional Agricultural Research Stations and major crop commodity programmes lack posts for agricultural engineering researchers (scientists) for farm power machinery research. Even though, Department of Agriculture (DoA) has nationwide network of agricultural extension programmes, the agricultural mechanisation related technologies are very limited due to a lack of approved posts of specialists in agricultural engineering. Major agricultural educational institutions, such as Agriculture and Forestry University and other agriculture related educational institutions also lack well established agricultural engineering and farm machinery disciplines.

Limited Access to Institutional Credit and Insurance Schemes

Farmers and agro-entrepreneurs currently face limited access to institutional credit, although interest rates of credit for tractors and other agriculture machineries are high. Farmers are mainly smallholders with limited cash to purchase and hire machinery. Agro-entrepreneurs also lack working capital. Furthermore, investment in farm machinery is highly risky due to various climate and market related risks in agriculture. Government of Nepal has recently initiated agricultural insurance programmes to reduce risk in farming. However, agricultural insurance schemes are not effectively implemented due to lack of adequate awareness among farmers, high transaction cost of administration and subsistence nature of farming in many parts of Nepal.

Limited Trained Human Resources

At present, the country lacks adequately skilled and experienced human resources in public and private sectors at all levels. The agricultural sector is less mechanised and commercialised because of the lack of skill related to manufacturing of farm machineries. Existing man power in public and private sectors are not only limited but they also lack adequate knowledge and skills in machinery manufacturing and servicing. Traditional artisans (blacksmiths) have been playing an important role in producing and repairing indigenous hand tools and bullocks drawn implements. They do however lack appropriate technical and capital support to develop their skill and volume of business.

Weak Agri-machinery Manufacturing Enterprise

Agri-machinery sub-sector in Nepal is emerging with dominance of small and medium sized enterprises. Currently, agri-machinery enterprises are mostly limited to repair and maintenance service sector and it lacks experience and technical knowledge related to business development services Their capacity to manufacture sophisticated agricultural machines and equipments is also very limited. The enterprises also lack information and adequate knowledge about production and marketing of quality machines and spare parts. Lack of quality control authority is also an issue for consideration.

High Prices and Uncertainty in the Availability of Rural Energy Sources

Farm mechanisation requires easy access to rural energy sources, such as electricity and petroleum products at affordable prices. But currently energy prices are very high and beyond the reach of small farmers due to lack of in-country production and stocking. Moreover, Nepal suffers from lack of adequate and uncertainty of access to energy sources (fuel, electricity) due to frequent load shedding and petroleum shortage for fueling power operated machines and manufacturing. Use of renewable energy for running and fueling machinery is very much limited.

Technological Options in Rural Mechanisation

Since late 1990s, some research centres in Nepal Agricultural Research Council (NARC) made efforts in technology development on agricultural mechanisation in collaboration with CGIAR centres. National Wheat Research Programme (NWRP), Agricultural Implements and Tools Research Centres (AIRC), Agricultural Engineering Division (AED) have been engaged in focusing development of conservation-agriculture (CA) technologies in collaboration with CGIAR centres mainly with CIMMYT. Recently the latest mechanisation technologies, such as Laser Land leveler (LLL); Direct-Seeded Rice (DSR); zero tillage on wheat, maize, and lentil crops; unpuddled transplanted rice (UTPR); and reduced tillage (RT) on wheat are being promoted by the collaborative research programmes. The Cereal Systems Initiative for South Asia (CSISA) project has also begun to validate and promote CA technologies again by providing a few units of various types of machines to groups of farmers in six selected districts of the Terai. CA-based technologies promoted by CSISA are considered to maintain soil health and are profitable as they reduce the cost of cultivation and enhance productivity. They also reduce drudgery, improve production efficiency and are sustainable

and environmentally sound. Considering the diversity of agroecology, farming systems and socio-jeconomic context of Nepal, selective mechanisation using appropriate technologies and practices are suggested for specific context and conditions. Two major agricultural and rural mechanisation technologies that are developed and being promoted by NARC and other agencies in Nepal are outlined below.

Agricultural Production Technologies (Tillage and Intercultural Operation)

The agriculture production developed and tested in NARC include technologies for tillage, planting and intercultural operations (AED, 2013; NARC, 2012). These include, (i) mechanised rice transplanter, which is able to transplant rice in 0.20 ha/hour. It saves 50-60 human labour per ha. This facilitates machinery use in inter-culture operation as it is planted in rows; (ii) maize dibbler for planting maize in rows is being promoted, which is efficient as compared to traditional manual sowing using plough; (iv) minimum tillage by power-tiller drills is a promising technology that performs three operations simultaneously- soil tilling, seed sowing, and planking. It saves on cost and overcomes the problem of poor plant-stand that can result from poor tilth and manual broadcasting (Joshi *et al.,* 2012). Hence, they are gaining popularity among small and medium-farmers in western Terai. Minimum tillage is beneficial which produces higher yields as compared with typical yields based on farmers' practice (Manandhar *et al.,* 2009; Pariyar *et al.*, 2001). The technology on intercultural operation that is tested and promoted includes, (iii) mechanised intercultural operation for maize using tractor. It includes tractor fitted with 4/11 tyne cultivator which is very efficient and saves 80% of human labour. There are also different types of irrigation technologies, such as pump sets, drip and sprinkle, etc., which are being promoted both by private and public sector organisations.

Technologies for Postharvest and Processing

There are some indigenous and newly promoted postharvest and processing technologies available in Nepal in agriculture and rural development. These include NARC developed and recommended technologies, such as corn sheller, millet thresher, coffee pulper, ginger peeler, seed cleaner, solar dryer (AED, 2013; NARC, 2012). These technologies help reduce cost, improve efficiency, and minimise women drudgery. The capacity of corn sheller technology is 15 kg maize shelling per hour whereas a woman can shell

manually only 5-8 kg per hour. Millet thresher cum pearler has a capacity of threshing and pearling 40-50 kg/hr of finger millet, which has been very useful to provide relief to women engaged in millet threshing. It is far better than conventional means as it has threshing efficiency of 97% and pearling efficiency of 98%.. The roller type coffee pulper has capacity of 60 kg/ hr, which has been transferred to private sector (more than 200 pulpers are commercialised). Solar dryer technology has been also developed and promoted to dry fresh and perishable products for value addition. This is appropriate to dry apple, vegetables, fish and meat at a temperature that ranges from 35to 55 degree Celsius.

Wheat thresher which was introduced from India in early 1970s is being popular in Nepal. Wheat threshing in Terai is fully mechanised with the use of thresher. It is estimated that over 100,000 wheat threshers are currently operating in Nepal. An important and popular technology being promoted through I/NGOs are biogas plants and solar dryers which have been energy efficient, climate smarts and spread widely. There are also some promising indigenous technologies which are being upgraded and promoted for processing, drying and cooking. These include rural water mills (*ghattas*), gravity rope ways, improved cooking stoves, etc.

Conclusions

Adoption and spread of agricultural and rural mechanisation technologies are increasing recently in Nepal with liberal import policies, increased connectivity and acute labour scarcity resulting from youth migration. Feminisation in agriculture is apparent. In addition, spill-over effect from India also played important role in the promotion of mechanisation in the bordering Terai districts. Agricultural machinery is having a positive impact on smallholders since they are efficient in accomplishing timely farm operations, reducing cost and improving product quality. With increased road connectivity, market accessibility and liberal economic policy, small-scale threshers, pump sets, and tillage equipments are now more widely available; these are less expensive, and suitable for small-holders even in rural hills and mountains. The country needs to identify, evaluate and promote widely promising existing indigenous and newly developed technologies on production, post-harvest and processing to spur agricultural growth in the country. Considering diversity of geography, agroecology, farming system and socioeconomic setting, selective mechanisation is suggested in Nepal based on specific context. Focus need to be given on

custom hiring of machines with enabling policy environment and programme activities. Special efforts should be made in the development, testing and promotion of resource conserving, environmentally safe, women and youth friendly mechanisation technologies suited to small-scale farming of Nepal.

Recommendations

Focus on Small-scale Mechanisation

Considering a small farm size and fragmented land holdings and difficult terrain of hills and mountains, promotion of small-scale machinery is most suited for Nepal. This case is supported by the evidence of success of small scale farm mechanisation of neighbouring countries e.g., China and Bangladesh (see Mandal, 2014 for illustration of Bangladesh case). Therefore, there is a strong argument of policy intervention in favour of small-scale machinery to smallholder farmers (see Biggs *et al.*, 2013 and Justice and Biggs, 2013). Small scale farm mechanisation focusing on women and youth friendly machineries is essential for enhancing access, improving production efficiency and addressing labour scarcity caused by youth migration and feminisation in agriculture (Gauchan, 2014). Promotion of small scale farm mechanisation is also best suited to the difficult topography of the hills and mountains of Nepal.

Custom Hiring of Farm Machineries

Considering the dominance of resource poor farm households and relatively large investment required for farm machinery at the individual household level, developing market for custom hiring will be best strategy to promote agricultural mechanisation in Nepal. This will require enabling policy and institutional environment that government of Nepal needs to promote and address. In such context, small-scale machinery is not always the best choice. Small scale machinery will be most suited to hills and mountains where terrains are difficult and plots are of smaller size and fragmented. In the flat land of Terai, where road connectivity exists and farm sizes are larger, relatively large size machinery (e.g. combine harvesters, and mobile threshers) will be the best technology and custom hiring of such expensive machinery will be viable economic option for the vast majority of farmers. In the past, custom hiring of large equipments was dominated by Indian machine owners but more recently, increasingly, Nepalese machine owners are being popular in custom hiring of equipments for tillage, harvesting and threshing. Therefore, there is a need to develop and implement an appropriate policy to facilitate custom hiring for the wider benefit of smallholders. Research on the evaluation of performance

of models of custom hiring services provision will be essential to design and recommend appropriate custom hiring options.

Cooperative Farming, Contract Farming, Land Banking and Land Consolidation

Considering a small and fragmented landholdings, use of machinery through the promotion of rural institutions, such as cooperative farming and community based organisations (CBOs) would be most suited in Nepal. This will provide economic use of tractors and other machineries when large number of farmers is organised into cooperatives for collective use to improve efficiency and reduce cost of production. In addition, for economic use of farm machinery, there is a need of regulation of land registration to encourage farmers' of larger land holding size. Furthermore, legislation on land leasing, contract farming and land banking are suggested options for promoting mechanisation and commercialisation of agriculture. Land consolidation is the obvious antidote to high levels of fragmentation. Consolidating a land owner's holding into a single location is by no means a simple task but it can be achieved by sale and purchase and through mutual exchange employing concept of land banking. Land consolidation has been successfully achieved elsewhere, most notably in Taiwan where agricultural productivity has increased by 32% (ADS, 2014).

Institutional and Human Resource Development in Agriculture and Rural Mechanisation

In order to promote farm mechanisation, there is a need to develop and strengthen institutional and human resource development in farm mechanisation at all levels (national, sub-national & local level) and ecological and development regions. This will require strengthening existing Agriculture Implement Research Centre (AIRC), Birganj and Agri Engineering Division (AED), NARC and establishment of new research centres in hills, mountains and mid/far western Terai region. Similarly establishment of agricultural engineering /farm mechanisation units in each of district agricultural development offices with adequate trained professional is needed for promotion of mechanisation extension programmes. Agricultural educational institutions also need to be strengthened for agricultural and rural mechanisation faculties and course curricula. Private sector manufacturing establishment and repair and maintenance workshops in different regions and locations are to be promoted and supported with suitable policies and programme. In addition, capacity

building of indigenous entrepreneurs (e.g. blacksmiths) and agro-related metal working industries is essential for in-country production of farm machinery prototypes that are adapted to fragmented lands and small holdings. Research capability in agricultural mechanisation needs to be strengthened.

Development and Promotion of Safe and Environment Friendly Mechanisation Technologies

Development of technologies on conservation farming with suitable accessories to farm machineries and attachments (e.g., planters, zero till drill, hoes, etc.) will help to improve efficiency in cultivation, conserve resources (water, energy) and reduce cost and labour demand. In addition, this will promote commercialisation of agriculture related to postharvest handling, storage and distribution of products. Other interesting areas of R&D are enhancing machine use efficiency, safety (both operators' safety and environmental safety), quality standards; and the prospects of using renewable energy like solar pumps, solar dryers, bio-fuel, biogas plants etc in operating farm machines. Research on development and piloting of advanced technologies, such as precision farming technologies is suggested to accomplish agricultural operations timely with the highest efficiency, thereby the quality of agricultural products specified by their ingredients, freshness, maturity and shelf life are improved, leading to higher prices at the market.

Targeted Policy Interventions with Portfolio of Incentives and Support Measures

The government needs to make provisions for appropriate policies and regulations on mechanisation, preferential treatment on capital machinery importation and multiple value added tax on imported raw materials. Tax and subsidy rationalisation is needed to promote use of farm machinery without distorting market and making compatible with private traders' incentives. Considering the need to focus on small-scale environmentally safe farm mechanisation, differentiated and targeted import duty is needed for raw materials, spare parts, machineries, accessories and attachments. Financing and credit policy with soft and easy loans for agricultural machineries and commercial agriculture in rural areas is suggested. Implementation of insurance schemes to minimise risks in farming is essential for the adoption of farm mechanisation and commercialisation of agriculture. This will require a portfolio of policy incentives and support measures for farmers and stakeholders to modernise and commercialise agriculture through enhancing

adoption of appropriate agriculture and rural mechanisation technologies. An immediate work plan is needed for the development of strategy and action plans for the implementation of new Agriculture Mechanisation Promotion Policy that includes most of these suggested policy options including formulation and implementation of other policies, legislations and regulations favouring commercialisation of agriculture. (e.g. Contract Farming Act, Land leasing legislation, Agriculture Land Use Act, Cooperative Act, etc.).

References

Agricultural Development Strategy (ADS). (2014). *Assessment Report and Policy Option Report. Prepared for Government of Nepal.* TA 7762-NEP preparation with the support of ADB, IFAD, EU, FAO, SDC, JICA, WFP, USAID, DANIDA, DFID, and World Bank, Agrifood Consulting International. Kathmandu.

Agricultural Engineering Division (AED). (2013). *Annual Report, 2012/2013.*, Nepal Agricultural Research Council, Khumaltar, Lalitpur, Nepal.

Biggs, S., Justice, S. and Lewis, D. (2011). "Patterns of Rural Mechanisation, Energy and Employment in South Asia: Reopening the Debate". *Economic and Political Weekly,* . XLVI (**9)**, pp. 78-82.

Biggs, S. and Justice, S. (2013). "Rural Mechanisation: A History of the Spread of Smaller Scale Technology in Some Asian Countries". A paper presented in the *Asian Regional Workshop on Rural Mechanisation: Policy and Technology Lessons from Bangladesh and Other Asian Countries*, 7-8 March 2013, Planning Commission, GoB and BRAC, Dhaka, Bangladesh.

Central Bureau of Statistics (CBS). (2012). *Nepal Living Standard Survey (NLSS). 2010/11.* National Planning Commission, Government of Nepal, Kathmandu

Central Bureau of Statistics (CBS). (2013). *National Sample Census of Agriculture Nepal, 2011/12.* National Planning Commission, Government of Nepal, Kathmandu.

Clarke, L. J. (2000). *Strategies for Agricultural Mechanisation Development the Roles of the Private Sector and the Government.* Agricultural Engineering Branch, Agricultural Support Systems Division, FAO, Rome.

Gauchan D., Pant, H. K , Gautam, S. and Nepali, M. B. (2012). "Patterns of Adoption of Improved Rice Varieties and Farm Level Impact in Stress Prone Rainfed Areas of Nepal"**.** In: S. Pandey, Gauchan, Malabayabas, D.M., Bool-Emerick, M. and Hardy, B. (ed.). *Patterns of Adoption of Improved Rice Varieties and Farm-Level Impacts in Stress-Prone Rainfed Areas in South Asia.* International Rice Research Institute (IRRI), Los Baños, Philippines.

Gauchan, D. (2014). *Thematic Report in Agriculture: National Strategic Framework for Nature Conservation (NSFNC).* A Report Prepared (draft) for National Planning Commission, Government of Nepal. Kathmandu.

Hossain, M., Rahman, M. Nath, S. C. and Chowdhury, A. (2013). "Nature and Impact of Agricultural Mechanisation in Bangladesh: Insights from Farm Level Surveys". *Regional Workshop on Rural Mechanisation: Policy and Technology Lessons from Bangladesh and Other Asian Countries*. 7-8 March 2013, Planning Commission, GOB and BRAC, Dhaka.

Joshi, K. D., Conroy, C. and Witcombe, J. R. (2012). *Agriculture, Seed, and Innovation in Nepal: Industry and Policy Issues for the Future.* Project Paper, IFPRI, December 2012.

Justice, S. and Biggs, S. (2013). "Rural and Agricultural Mechanisation in Bangladesh and Nepal: Status, Processes and Outcomes". In: Kienzle, J., Ashburner, J.E. and Brian G. Sims (Ed.). *Mechanisation for Rural Development: A Review of Patterns and Progress from Around the World.* Chapter 4. FAO, Rome.

Mandal, M.A.S. (2014). "Agricultural Mechanisation in Bangladesh: Role of Policies and Emerging Private Sector". Powerpoint slide presentation. NSD- IFPRI Workshop on *Mechanisation and Agricultural Transformation in Asia and Africa: Sharing Development Experiences*. 18-19 June 2014. Beijing, China.

Manandhar, G. B., Adhikary, S. K. and Sah, G. (2009). "Sustainable Agricultural Practices and Technologies in Nepal". In: *TECH MONITOR: Special Feature: Sustainable Agriculture* (Jan-Feb 2009).

Ministry of Agricultural Development (MoAD). (2012). *ADS Options and Next Steps: Private Sector*. Government of Nepal. Jim Tomecko and Poshan B KC. Kathmandu, Nepal.

Ministry of Agricultural Development (MoAD). (2014). *Agriculture Mechanisation Promotion Policy*. Ministry of Agricultural Development (MoAD), Government of Nepal. Kathmandu, Nepal.

Ministry of Finance (MoF). (2013). *Economic Survey, 2012-13*., Government of Nepal. Kathmandu, Nepal.

Nepal Agricultural Research Council (NARC). *Annual Report-2012*. Kathmandu, Nepal.

Pariyar, M. K., Shrestha, K . B. and Dhakal, N. H. (2001). *Baseline Study on Agricultural Mechanisation Needs in Nepal*. Facilitation Unit, Rice-Wheat Consortium for the Indo-Gangetic Plains, CG Block, National Agricultural Science Centre (NASC) Complex, New Delhi, India.

Pudasaini, S. P. (1976). *Resource Productivity, Income and Employment in Traditional and Mechanical Farming of Bara District, Nepal*. MSc Thesis, University of the Philippines, Los Baños, The Philippines.

Shrestha, S. (2012). *Status of Agriculture Mechanisation in Nepal*. Agricultural Engineering Division (AED), NARC, Khumaltar, Nepal. Page 1-4. www.unapcaem.org