



Early innovations were implemented and tools that increased the productivity of draft animals and assisted farmers in preparing land for cultivation, planting and seeding, and managing and harvesting crops

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farmers purchase the farm machines through credit provided by financial institutions. The loan recovery against farm machine purchases has enjoyed an excellent record

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3065/14

The Impact of Mechanization on Agriculture

By John F. Reid



Labour intensive work to a not so intensive

In the future, agricultural machines will become data-rich sensing and monitoring systems.

Significant challenges will have to be overcome to achieve the level of agricultural productivity necessary to meet the predicted world demand for food, fiber, and fuel in 2050. Although agriculture has met significant challenges in the past, targeted increases in productivity by 2050 will have to be made in the face of stringent constraints—including limited resources, less skilled labor, and a limited amount of arable land, among others.

The metric used to measure such progress is total factor productivity (TFP)—the output per unit of total resources used in production. According to some predictions, agricultural output will have to double by 2050 (GHI, 2011), with simultaneous management of sustainability. This will require increasing TFP from the current level of 1.4 for agricultural production systems to a consistent level of 1.75 or higher. To reach that goal, we will need significant achievements in all of the factors that impact TFP.

Mechanization is one factor that has had

a significant effect on TFP since the beginning of modern agriculture. Mechanized harvesting, for example, was a key factor in increasing cotton production in the last century (Figure 1). In the future, mechanization will also have to contribute to better management of inputs, which will be critical to increasing TFP in global production systems that vary widely among crop types and regional economic status.

For example, a scarce, basic resource that will have to be managed much better is

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water, a critical input in agricultural production. Both the efficiency and effectiveness of water use will have to improve dramatically.

Today, approximately 70 percent of withdrawals of fresh water are used for agriculture (Postel et al., 1996). By 2025, 1.8 billion people are expected to be living in areas with absolute water scarcity (UN FAO, 2007), and two-thirds of the world population will live in water-stressed areas. Improving water management will have to be achieved by more efficient irrigation technology and higher efficiencies in whatever technologies farmers are currently using.

In this article, I define the current state of agricultural systems productivity and demonstrate how information and communication technologies (ICT) are being integrated into agricultural systems. I also describe how the integration of ICT will create opportunities for increasing agricultural-system productivity and influencing productivity beyond the agriculture value chain.

The Impact of Mechanization on Productivity

Agricultural mechanization, one of the great achievements of the 20th century (NAE, 2000), was enabled by technologies that created value in agricultural production practices through the more efficient use of labor, the timeliness of operations, and more efficient input management with a focus on sustainable, high-productivity systems. Historically, affordable machinery, which increased capability and standardization and measurably improved productivity, was a key enabler of agricultural mechanization.

A major turning point occurred when tractors began to replace draft animals in the early decades of the 20th century. Early harvesting methods had required separate process operations for different implements. With tractors, the number of necessary passes in a field for specific implements was reduced, and eventually, those implements were combined through innovation into the “combination” or combine harvester.

For most of the 20th century, four key factors influenced increases in the rate of crop production: more efficient use of labor; the timeliness of operations; more efficient use of inputs; and more sustainable production systems. These four drivers played out at different rates in different crop production systems, but always led to more efficient systems with lower input costs. Technological innovations generally increased mechanization by integrating functional processes in a machine or crop production system and by making it possible for a farmer to manage increasingly large areas of land.

By the late 20th century, electronically controlled hydraulics and power systems were the enabling technologies for improving machine performance and productivity. With an electronically addressable machine architecture, coupled with public access to global navigation satellite system (GNSS) technology in the mid-1990s, mechanization in the last 20 years has been focused on leveraging information, automation, and communication to advance ongoing trends in the precision control of agricultural production systems.

In general, advances in machine system automation have increased productivity, increased convenience, and reduced skilled labor requirements for complex tasks. Moreover, benefits have been achieved in an economical way and increased overall TFP.

Worksite and Value Chain Productivity

The next step in automation and control is to move beyond individual vehicle systems to the optimization of production systems and farm worksites. To achieve this goal, we have developed the beginnings of vehicle and machine systems that can both sense and control with precision. These systems can be driven by data from a variety of sources to provide precision control. For example, they are capable of collecting, storing, and transferring information about the crop, field, and machine state at the time of field operation. They can also receive data from public and private

data sources.

Furthermore, data collected by machines can be transferred to farm-management systems as well as to public and private sources that require information about production management for quality, compliance, or value-added purposes. Thus, we are entering an era of emerging field and farm optimization systems that can drive up TFP of the worksite, including machines, geographies, and cropping systems.

As intelligent mobile equipment for worksite solutions has evolved over the last 20 years, agricultural mechanization has also evolved from a bottom-up integration of the foundations of ICT applied to basic mechanization systems required for crop production. The primary machine capabilities of precision sensing, advanced control systems, and communications have created the potential for the emergence of CPS from production agricultural systems.

Although these advanced technologies are not uniformly distributed among platforms and production systems, where they exist, there are opportunities to leverage ICT to increase production systems capabilities. Looking ahead, it is expected that the business value of ICT will expand to additional platforms.

Technologies integrated on vehicles must work seamlessly with other systems. Drawbacks of some initial attempts for ICT capabilities have been the significant time required for setup or management, the lack of a common architecture, the lack of standardization among industries, and the lack of standardization with the farmer in mind as a user of ICT. Recently, several organizations have been working to develop standards, and some improvements have already been developed or are in process (ICT Standards Board, 2006; U.S. Access Board, 2010).¹

Centers that store machine, agronomic, and social knowledge will aggregate data to provide value-added services for machinery operation and farm

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management. Some of these data may be collected by farmers, and some will be provided by public and private sources of agricultural information. Some data sources, such as remote sensing, have been mentioned, but a number of others will emerge as the aggregated knowledge in efficient production agriculture increases.

Centers with machine knowledge can help increase equipment uptime and anticipate machine system failures based on vehicle state variables in operation. Machine data that provide a better understanding of machine use can also lead to more efficient system designs that meet the needs of farmers. Agronomic data will create new opportunities for intensive modeling and simulation that can improve production efficiency by anticipating the impact of weather and various production methods.

In the future, ICT will enable the development of new platforms that can provide more support to production agriculture by taking advantage of opportunities to connect farmers, the value chain, and society in ways that are beyond present capabilities. The German-funded iGreen project, for example, is working on location-based services and knowledge-sharing networks for combining distributed, heterogeneous public and private information sources as steps toward future ICT systems (iGreen, 2011). Today, we are extremely close to having true CPS and control systems for measuring the “pulse” of agricultural productivity on planet Earth.

Conclusion

Agricultural mechanization will be a key factor to achieving our TFP goals and feeding a growing planet. Looking ahead, agricultural machines will become data-rich sensing and monitoring systems that can map the performance of both machines and the environment they work on with precision resolution and accuracy, and this capability will unlock levels of information about production agriculture that were heretofore unavailable.

Field Demonstration of Multi-Functional Mini Power Tiller

19 August: His Excellency, Lyonpo Yeshey Dorji, Minister for Agriculture and Forests (MoAF), Offtg. Director General, Department of Agriculture, Division Chiefs and officials of various departments/divisions under MoAF visited Bondey Farm today to attend field demonstration of multi-functional mini power tiller products of M/S SAS Motors Limited, Manesar, Gurgaon, Haryana, India.

His Excellency informed the gathering that MoAF is always exploring alternatives to overcome farm labour shortage in Bhutan by introducing handy and affordable farm machineries. He also added that the machines demonstrated today will be thoroughly examined by the Agriculture Machinery Centre and its technical professionals based on the appropriateness of introducing such farm machines in our soil.

The live demonstration of farm machineries include Angad Power Tiller which is found to be suitable for small and marginal farmers for agricultural and horticultural purposes and Angad Diesel Hal a total solution for mechanization of small farms which can plough, seed, de-weed, spray and irrigate with other required accessories. The Chief Executive Officer of SAS Motors Limited Mr. Arvind Sinha said that Angad Diesel Hal includes special features such as gender friendly and highly affordable, very low operation and maintenance cost, light weight and easy to operate, can be operated on steep inclines, stable on uneven fields and suitable for different crops and farming operations. He also expressed his gratitude to MoAF and Royal Government of Bhutan for the wonderful opportunity to demonstrate his company's products in Bhutan. SAS Motors Limited is established with the aim to produce low-cost mechanization technology. The company is engaged in manufacturing and marketing of 'Angad Diesel Hal'. SAS Motors also provides a range of multi utility agricultural equipments and tractors.

According to Program Director, AMC, the demonstration was arranged following His Excellency's visit to SAS Motors Limited beginning this month and it is one of the Ministry's effort and initiative to attract and promote the farming activities by replacing the drudgery in farming community.

By Penjor, ICS

Gearing towards improved agriculture technology – Agriculture Machinery Centre



With majority of the Bhutanese living in remote villages they constitute the primary beneficiary for Bhutan's development endeavor. Being entirely dependent on subsistence farming, their daily lives are entwined in agricultural activities. Constrained by rough terrain, small acreage, lack of farming technology and shortage of farm labor, farming in Bhutan is associated with drudgery, hardship and adversity. Traditionally, for most farmers it is a way of life to plough, sow, weed and harvest to subsist until the next season and to repeat the cycle all over again.

AMC was established in 1983 with the vision to realize national food self sufficiency and making the life of its rural folks a self sustaining one. This vision placed the Bhutanese farmers at the core of all agricultural development activities. AMC aligned itself strategically to contribute towards the achievement of the vision through enhanced effectiveness and efficiency in Bhutanese farming practices. It embarked on the program to mechanize Bhutanese agriculture through use of appropriate farm machinery, equipments and tools.

Over the years, AMC has partnered itself with the Bhutanese farmers to choose, create and innovate agricultural technologies and farming practices which are appropriate to the Bhutanese farm terrain and ecological conditions.

It has not only contributed significantly in the national goal of food self sufficiency but has also been an instrumental agent in alleviating



Demonstration of Rice sowing machine



Farmers transporting farm machines to remote villages (Sakten)

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**Cont. from page 4 : Agriculture Machinery Centre**

drudgery in Bhutanese agriculture.

Located in the picturesque and fertile valley of Paro in Western Bhutan, AMC today is a responsive partner to the Bhutanese farmers. Functioning under the aegis of the Department of Agriculture, Ministry of Agriculture and Forests, AMC has worked closely with the farmers in developing agricultural practices through innovation, mechanization, promotion of new technologies and capacity development.

Bhutan receives gracious support of the Japanese government through the 2KR-II Grant and executed for the last 26 years. Achievements in mechanization of farms in Bhutan is due to the 2 KR grant. AMC today continues to receive the grant which is aimed at enhancing the livelihood of the underprivileged farmers.

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The aim of the AMC is achieved through the following objectives:

- a) Creation and innovation of indigenous farming tools suitable to Bhutanese farms.
- b) Promotion of improved agriculture technology in the country.
- c) Effective and efficient distribution of agriculture equipments to the farmers.
- d) Capacity development of the farmers in the use of improved technologies and farming practices.
- e) Act as the regulatory body for quality and safety

Achievements – Creating delight for Bhutanese farmers

Mechanization has touched the lives of many Bhutanese farmers through the various services it provides. AMC has been instrumental in the transformation

of the basic tools to labor and energy saving farm machines and tools. It has also been a major influence in the use of improved farming techniques. The organization takes pride in the successful creation and innovation of many tools and implements that are now widely used by Bhutanese farmers. Another significant achievement is the enhancement of capacities of our farmers to embrace and apply new farming techniques.

Many kinds of farm machines have made inroad into the Bhutan's unfriendly farm lands. Farm machines such as power tillers have also made way into farms which are inaccessible by road. Farmers have carried the machines and reassembled at their remote farms. A testimony to the success of the promotion of farm mechanization is the increasing demand for different types of equipments and machines from all over the country. AMC has stood a trusted partner to the Bhutanese farmers as they beat the constraints of a rough and landlocked farming terrain.

The farmers purchase the farm machines through credit provided by financial institutions. The loan recovery against farm machine purchases has enjoyed an excellent record. This is an indication of the benefits translating directly into enhanced income for the farmers.

Increasingly, farmers have been adopting new practices of farming. Some of the practices worth mentioning include cultivation, crop processing operations, nursery raising, paddy transplantation, rice milling, flour milling and oil milling. The adoption of new technology not only enhances yield and better output, it also makes agriculture a commercially viable enterprise. AMC takes pride in having promoted more than 6000 small scale Rural Agro-machinery based enterprises, spread throughout the country and mostly in the rural areas. Each enterprise has the capacity to provide livelihood to a household, while simultaneously alleviating manual labour of a community of a minimum of 25 households. These ventures have proved to be highly profitable and sustainable investments.

Interventions in Bhutanese farming.

Interventions in Bhutanese farming are aimed at ending drudgery, saving costs, improving yield and enhancing productivity through the use of suitable farm machinery, tools and equipment. Much of the farming drudgery is prominent in the land preparation, transplantation, weeding, harvesting, threshing, drying and storage. These agricultural works are traditionally carried out manually without or with rudimentary tools and implements. Hence farming was characterized by back breaking hard work with low productivity and yield. The AMC interventions have made much headway in making farming an attractive venture with less hardship, better yields and greater productivity. Machines received under Japanese KR II grant are sold to the farmers at subsidized costs. The sale proceeds are deposited as counter part fund in financial institution. With the counter part fund, about 300 activities valued at Nu. 400 mill had been initiated which are aimed at enhancing rural livelihood and accessibility. The activities cover livestock, agriculture and conservation and are spread throughout the country. Such initiatives are making significant impact in alleviating poverty in the entire country.

Future prospects

Farm mechanization will continue to assume an important role in the lives of the Bhutanese farmers in their quests for quality live. Enhanced productivity, improved quality yield, drudgery free farming practices, better farm inputs and easy market accessibility are some of the important aspects for the future.

AMC must fulfill the expectations of the farmers arising from its role of the pursuit for labour saving technologies. It shall continue to create, innovate and chose for Bhutanese farmers the best machines, farming practices and technologies. The demand placed on the AMC by the farming communities is overwhelming and is increasing rapidly. It is expected to rise for sometime in the future. Although, the present need is fulfilled, there will always be a demand for new technologies to meet new challenges.



Leisure

Announcement: RNR Extension Manual 2015

The Information & Communication Services (ICS) is in the process of publishing RNR Extension Manual 2015. Therefore, ICS would like to request all the departments/agencies to kindly furnish any update required with regard to their respective agencies based on RNR Extension Manual 2014 for finalization.

Kindly contact Mr. Penjor at 321142/323765 for further clarification, updates and comments. Please note that considering the limited budget of printing, ICS will not be able to spare Extension Manual for ESP and GSP staffs.

Sudoku Puzzle

Fill in the grid with digits in such a manner that every row, every column and every 3x3 box accommodates the digits 1-9, without repeating any. Answer in the next issue

9			8			6	5	
			7			3	9	
		4			2			
		5				1	4	
7	2						6	8
	4	8				9		
			2			8		
	7	1			6			
	9	2			3			5

Announcement Cordycep is dutiable in Thailand

This is to inform all concerned that, Cordycep is a dutiable good in Thailand. The Department of Agricultural Marketing and Cooperatives would like to recommend anyone wishing to export cordyceps to Thailand to kindly get import permit from the Thai Department of Health and Food Control and then declare at the customs at Bangkok airport. Then one has to pay 30 % duty on Thai value for cordyceps, which is fixed at Thai Baht 200,000 -2, 50,000 per kg (Nu. 4-5 lakhs per kg) depending upon quality assessed.

And in the event, if the cordyceps is illegally imported then the goods will be confiscated for good. If confiscation is challenged, the case will be forwarded to Thai airport police, whereby, the illegal importer will be detained and charged with criminal acts, including imprisonment. Then 130% penalty will be imposed and the goods will not be returned as well. The export permits issued by Bhutan shall not be sufficient to legally import to Thailand.

For more Thai customs regulation details, kindly visit Thai Customs website or contact us at 322909/335741.

-DAMC

Serthi farmers trained in Satuwa nursery development

By Karma Leki and Jigme Thinley, Dzongkhag Forestry Sector, Samdrupjongkhar

Satuwa, botanically known as Paris polyphylla is a rhizomatous perennial plant and is used for medicinal purposes. Satuwa is reported to be grown in Serthi, Lauri and Gomdar geogs in Samdrupjongkhar Dzongkhag.

The Dzongkhag has a high potential for Satuwa domestication as it can be cultivated through replanting of wildlings or through seeds. It can get attractive prices due to its high demand. Traders have also expressed their interest in providing technical support to the growers.

However, due to unsustainable harvesting practices, the availability of Satuwa is decreasing rapidly. When the farmers started Satuwa cultivation two years ago, they could collect 8-10 kgs in a day but now it is less than 1 kg a day. Further, significant losses are observed due to lack of poor post-harvest management. There is also a lack of transparency and accountability in the value chain due to a huge difference between farm gate price (Nu. 100/kg) and the selling price in India (Nu. 1800/kg).

Considering the above reasons, farmers of Deptsang village in Serthi geog have started the domestication of Satuwa in nursery. They were provided hands on training on its nursery development (2013-2014) with a fund support of Nu. 0.2 million from the Market Access and Growth Intensification Project

During the training, farmers prepared the nursery beds measuring 10m x 1m and raised 5-10 cm above ground level. They kept sufficient spaces between two beds to water it and carry out weeding easily. In order to protect the beds from rainfall, hailstorm and sunlight, green house nets were used at a required height of 5-6 ft.

Farmers collected 1300 nos. of fresh young rhizomes from the non-wood forest products (nwfps) areas and planted. The survival of growth is much better and after two months of plantation, some have

started flowering. The two members water the nursery twice a day for better results.

Nursery is located in the village itself where user group can monitor easily; it has been fenced with wire mesh to protect it from cattle. Some farmers have even tried Satuwa in their kitchen garden together with banana and bamboo as it needs a shade.

Although the forest in Deptsang is rich in resources, the village had remained isolated for last many years with no other source of income particularly due to lack of road access. The farm road had reached the village only in 2014.

With nwfps groups and nursery in place, Deptsangpas look forward to elevate their living standard. Women's participation right from the planning to decision making on nursery management had been very strong. Tshewang Chezom, one of the participants says, 'The nursery is the product of our decision'.

The nursery will be diversified with

species and farmers will be growing Satuwa in their field with seeds from the nursery. There are twenty eight members in the nwfps group. With such initiative, it is expected that the group will earn additional income without destroying the natural forests.

Submit articles for
RNR Newsletter
(September) to

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Satuwa flowering in nursery



Facilitating market opportunities for mango growers

By Sangay Jamtsho and Tek Bdr. Tamang, RAMCO

Mango production in the east has picked up well over the past few years. Earlier, farmers were able to sell at local markets while few managed to sell to Bumthang. But with the increase in production, local markets were not able to consume large quantity. In some cases, more than 30% of the production has been wasted.

The participations from middlemen and traders were not of much help. The trial marketing was also carried out in Thimphu to see the consumer preference in 2011 and 2012. Substantial volume was produced which led to selling problem in the local markets.

The seasonal advantage of mango production in Bhutan over India which was once considered as an opportunity is now no more with cold stores in India making mangoes available all year round. Further, the established market linkage between vendors and traders for outside mangoes made it difficult to find reliable vendors for local ones. The mangoes price, Nu.10-15/kg offered by local industries did not encouraged farmers for selling to them.

Considering the issues, the Regional Agricultural Marketing and Cooperatives Office (RAMCO), Mongar; Dzongkhag Agriculture Sectors of Mongar, Trashigang and Lhuentse; RDC-Wengkhar and Food Corporation of Bhutan Ltd. (FCBL) jointly provided various supports in order to assist

marketing of mangoes.

RAMCO, RDC-Wengkhar and the Sectors carried out the production assessment in all the mango producing areas. RAMCO facilitated farmers to carry out the proper harvesting, sorting, grading and packaging of mangoes. The mangoes were transported in plastic crates to prevent damages. They also helped the transportation of mangoes to Thimphu. To establish better market, RAMCO provided timely market information (price) from Thimphu, Mongar and FCBL.

For market linkage, FCBL agreed to do physical marketing of mangoes in Centenary Farmer's Market, Thimphu. Accordingly, FCBL procured all mangoes and stored in cold storage at Wangsisina to supply as per the market requirements. While exploring, FCBL found a reliable market in high end hotels but due to quality and consistency in farmers supply, it was found difficult to establish a proper linkage with them. Later, the mangoes price was fixed and

agreed between farmers and FCBL based on the market forces.

With such joint supports, farmers were able to market 34.6 MT of mangoes amounting Nu.1.387 million. Out of it, 25.1 MT amounting Nu.0.991 million was sold to Thimphu while left over quantity was sold in local markets. The joint effort has also helped to bring smiles to the faces of about 15 farmers as mango has become a source of income for them.

As part of future initiatives, the linkage between farmers and FCBL will be strengthened as FCBL has helped to create assured market for mangoes. The team will try to promote export of mangoes in neighbouring countries where there is no production. The team will further encourage group marketing, intensify production, improve orchard management to produce quality mangoes and find easy markets; establish processing/pulping unit and cold storage facilities for mango growers.



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