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Agriculture, seed, and innovation in Nepal: Industry and policy issues for the future

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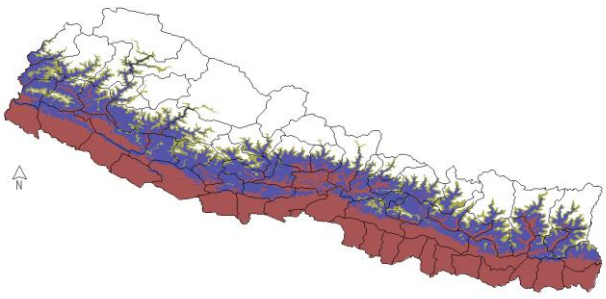
INTRODUCTION

Nepal is a landlocked country of 27 million people residing across a land area of more than 147,000 km^2. Nepal is divided into three major geographic regions (Figure 1.1): the Terai and inner Terai; (34,000 km^2); the Hills (61,000 km^2); and the Mountains (52,000 km^2).

The Terai and inner Terai lie at the lowest altitudes and are the most productive regions agriculturally. Mostly they enjoy subtropical warm humid climatic conditions favorable for growing three crops in a year. There is considerable variation in climate from east to west and great diversity for water according to local topography and the availability of irrigation.

When agroecology is considered, the hill regions are divided into three (Table 1.1) resulting in five distinct domains that vary in their resource endowment, land-use systems, farming systems, cropping patterns and intensities, and access to road and market networks. Population distribution in Nepal is related more to the proportion of cultivated land than to the geographical area. For example, Terai and inner Terai are home to 48.4 percent of the population and cover 56 percent of the total cultivated land; hills account for 44.3 percent of population and 37 percent of cultivated land while mountains accommodate 7.3 percent of the total population and have only 7 percent of the cultivated land (Nepal, National Planning Commission–WFP–NDRI 2010).

FIGURE 1.1—MAJOR PHYSIOGRAPHIC REGIONS OF NEPAL



Source: Nepal, National Planning Commission 2010a.

TABLE 1.1—AGROECOLOGICAL DOMAINS OF NEPAL

Agroecological domain	Altitude range (m)	Local names for the region	Importance in terms of agricultural production
Terai and river basin	80–600	*Terai, Tar, Bensi, Phant, Khonch, Kachad*	Most important
Low hills	600–1,000	*TalloPahad*	Third most important
Middle hills	1,000–1,600	*Deurali, Hatiya, Madhya Pahad*	Second most important
High hills	1,600–2,300	*Lekh, Kharka*	Fourth most important
Mountains	>2,300	*Himal*	Least important

Source: Vaidya and Floyd 1997.

Brief historical background to agriculture development in Nepal

The predominant agriculture system in Nepal was pastoralism and in the 12th century the introduction of terracing, plowing methods and the construction of irrigation systems favored the intensification of agriculture. Rice, barley, several species of millets, and legumes were native to the region, while the introduction of maize and potatoes in the 18th century allowed an increase in cropping intensities particularly in the *Bari* lands (upland) of higher altitudes. This resulted in expansion of the area under cultivation from the valley bottoms through to terraces on the valley slopes (Seddon et al. 1979).

During the 19th century, population growth influenced the process of intensification of agriculture, and led to opening up of virgin lands for cultivation, especially in the Terai. In the 1950s, the eradication of malaria in many areas of the Terai and the clearance of forests accelerated the migration of hill people, as well as people from India, to the Terai.

Current agricultural situation

Nepal is predominantly an agrarian country with 88 percent of the population living in rural areas and 78 percent of the adult rural population engaged in agriculture (Nepal, Ministry of Agriculture and Cooperatives 2008). Nepal currently has 3.2 million hectares of cultivated land (and nearly 1.0 million hectares of additional land that could be brought into cultivation) (LRMP 1986). The 3.4 million total holdings average about 0.8 hectare of land per holding. In this mountainous country, only 16 percent of the land is agricultural land (Nepal, National Planning Commission–WFP–NDRI 2010).

Because of rapid increase in population, land holdings are fragmented and scattered. As a result, agriculture is mostly subsistence in nature. As per the census of 2001, 61 percent of the total population engaged in agriculture and 78 percent of farming households have their own agricultural land (Nepal, National Planning Commission 2002) but the holdings are small. Nearly half (47 percent) of all holdings are less than 0.5 hectare and 28 percent are between 0.5 and 1 hectare land area (so 75 percent of the total holdings are less than 1 hectare) (Nepal, National Planning Commission 2003). Given average yields, a farm household would need at least 0.64 hectare of land in the mountains, 0.52 hectare in the hills, and 0.42 hectares in the Terai to produce enough food to feed a family of 6 members (Nepal, National Planning Commission–WFP–NDRI 2010). The share of cultivable land per person for the mountain region (0.3 hectare) comfortably fulfills this criteria, while the hill and Terai regions are facing extreme population pressure with implications for producing adequate food (Nepal, National Planning Commission 2006; Subedi 2003). Nepalese farmers grow crops under uncertain environments as rain-fed farming accounts nearly for two-thirds of the cultivated area; farmers cultivating rain-fed farms live in the most marginal, risk-prone, and poverty-stricken regions in the country (Nepal, National Planning Commission 2008).

The agriculture sector accounts for one-third of the gross domestic product (GDP). Its contribution to employment, especially in rural areas, is quite considerable and there is a high dependence on agriculture as the major source of income. Returns from the agriculture sector have remained low and the per capita GDP is only US$140 per agricultural worker (Nepal, Ministry of Finance 2008).

With little scope for increasing area under cultivation, population growth has led to falling average farm size and increasing fragmentation, which results in growing poverty. However, because there is currently very low agricultural productivity, there is great potential for a rapid improvement through modern technologies. To translate the potential into reality, huge investment is needed in areas such as irrigation, agricultural roads, land improvement, agricultural mechanization, equipment, and the use of purchased inputs.

Poverty and human development in the context of current state of transition

Nepal is in a state of transition. Following the recent cessation of civil unrest through a comprehensive peace accord, the country remains in the (long) process of constitution writing. This has important implications for the general peace and security and the pace of development in the country.

Poverty can be measured in various ways. The Government of Nepal uses the cost-of-basic needs (BCN)[1] approach. Government statistics vary in their assessments of the extent of poverty. For example, the Nepal Living Standard Survey[2] (NLSS) estimated that nearly 31 percent of the total population was living below the national poverty line and 41 percent were consuming less than the minimum calorie requirements in 2010. In terms of purchasing power parity (PPP), the percentage below the poverty line would be more than 24 percent (Nepal, Ministry of Finance 2010). In contrast, the Multidimensional Poverty Index[3] (MPI) indicates more than 18 million (66 percent) living in poverty, and 78 percent of them with an income of up to $2 a day (Table 1.2). Out of these, 67 percent are engaged in agro-based employment and 11 percent work as agricultural laborers.

In spite of long social unrest and almost stagnant growth, there were positive changes in education and health indicators; average literacy and net enrollment rate in primary education and values for some of the health indicators improved compared with the previous decade (Nepal National Planning Commission, 2010b). Some of the indicators, such as average literacy and net enrollment rate in primary education have achieved high levels (Table 1.2).

The income gap between urban and rural, as well as among various geographical regions and groups, is still extremely wide in Nepal. The Gini coefficient, a widely used indicator for income inequality, was 0.34 in 1992–93 but reached 0.41 in 2003–04 suggesting that the income growth rate of the rich has been higher than that of the poor (Nepal, Ministry of Finance 2010).

TABLE 1.2—DEVELOPMENT INDICATORS FOR NEPAL

Indicator	Value	Year	Source
Population size (millions)	30.49	2011	Preliminary census results by CBS, NPC
Population growth rate (%)	2.25	2009–10	CBS 2010
Life expectancy at birth (years)	63.7	2006	UNDP 2009
GNI per capita (US$)	472	2008–09	CBS 2009
Human Development Index (HDI)	0.509	2006	UNDP 2009
Real GDP growth rate (average %)	3.95	2008–09	CBS 2009
Literacy rate, 15–24 years (%)	86.5	2008	CBS 2008
Net enrollment rate in primary education (%)	93.7	2009	DOE 2009
Underweight children under age five (%)	38.6	2006	MOHP et al. 2007
Under-five mortality rate (per 1,000 live births)	50	2009	FHD 2009
Maternal mortality rate (per 100,000 live births)	229	2009	FHD 2009
HIV/AIDS prevalence, 15–49 years (%)	0.49	2007	NCASC 2009
Population below national poverty line (%)	25.4	2009	NPC 2010
Multidimensional Poverty Index (MPI)§	0.35	2010	University of Oxford
Proportion of MPI poor (H)	0.65	2010	University of Oxford
Average intensity of deprivation (A)	0.54	2010	University of Oxford

[1] The BCN approach establishes a poverty line that represents the level of per capita expenditure required to meet basic needs. For Nepal, an average of Rs.7, 696 (US$110) per year per person has been considered as the national poverty line and the minimum calorie requirement has been set at 2,144 kilocalorie per person per day (Nepal, National Planning Commission 2004).

[2] The list of abbreviations and acronyms is annexed to this paper.

[3] Multidimensional Poverty Index (MPI) was constructed by Oxford Poverty and Human Development Initiative (OPHI) for the UNDP's 2010 Development Report (http://hdr.undp.org/en.). MPI = H*A

Where H =Incidence of Poverty and A=Average intensity across the poor

Number of MPI poor people (millions)	18.3	2010	University of Oxford
Share of $1.25-a-day income poor (%)	55	2010	University of Oxford
Share of $2-a-day poor (%)	78	2010	University of Oxford
HDI category	Medium	2010	University of Oxford

Sources: As indicated.
Note: GNI = gross national income.

Poverty is not evenly spread across the country as a result of differences in various factors and their interactions. At 35 percent, the rural poverty level is more than three times as high as the urban poverty level in 2003–04 (Nepal, National Planning Commission 2005), and agriculture shows the highest concentration of poverty (Gulati et al. 2010). The hills and mountains have a higher percentage of poor people than the Terai (Table 1.3), but in terms of absolute numbers the Terai has the highest concentration of poor people due to high population density. The Hills and Terai of the western and far western regions, as well as the hills and mountains of the eastern development regions, are the poorest with more than half of the population living below poverty. There was considerable reduction in poverty in the mountains and Terai from 1995–96 to 2003–04. However, in the hills there was a 13% increase in the proportion of poor people (Table 1.3) even though there was a decrease in the poverty head count during the same period. Despite overall reduction in poverty levels in the country, poverty for those self-employed in agriculture increased by 10 percentage points. One of the major contributing factors in poverty reduction has been the income from remittances, which accounts for more than 20 percent of GDP (Gulati et al. 2010).

TABLE 1.3—POVERTY HEAD COUNT AND DISTRIBUTION OF POOR POPULATION IN NEPAL

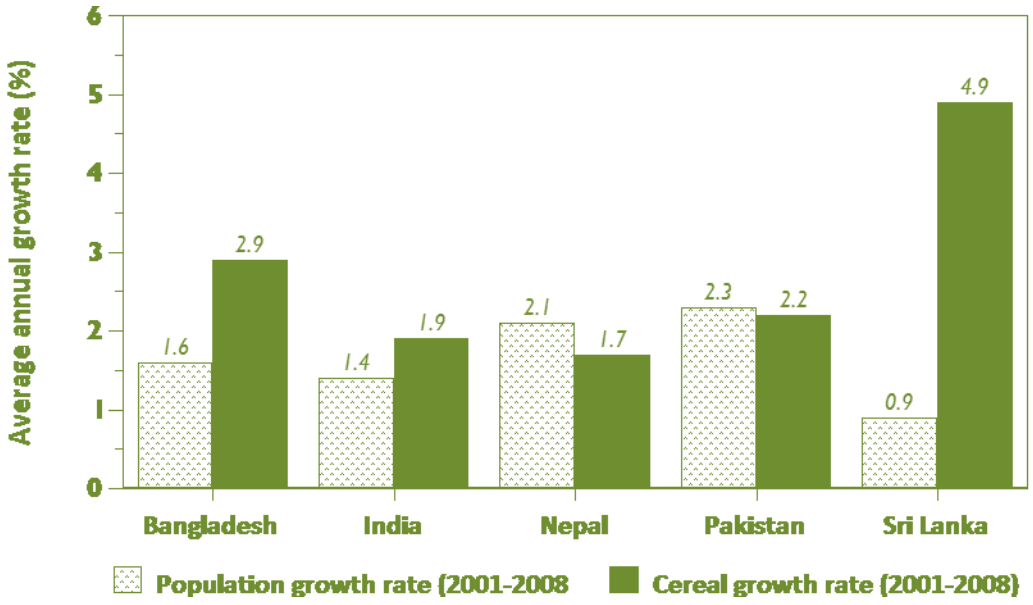
Description of poverty	Poverty head count (%)			Distribution of the poor population (%)		
	1995–96	2003–04	% change	1995–96	2003–04	% change
Nepal	41.8	30.8	-26	100.0	100.0	-
Urban	21.6	9.6	-56	3.6	4.7	31
Rural	43.3	34.6	-20	96.4	95.3	-1
Mountain	57.0	32.6	-43	10.7	7.5	-30
Hill	40.7	34.5	-15	41.9	47.1	12
Terai	40.3	27.6	-32	47.4	45.4	-4
Self-employed, agriculture	43.1	32.9	-24	60.7	66.9	10
Wage-earner, agriculture	55.9	53.8	-4	15.7	10.9	-31
Farmers with <0.2 hectare of land	48.0	39.0	-19	23.0	25.0	9
Farmers with 0.2–1.0hectare of land	45.0	38.0	-16	44.0	51.0	16

Source: Nepal, National Planning Commission 2005, adapted from Gulati et al. 2010.

Food security in Nepal

Nepal is one of the most food-insecure countries in Asia in large part because the average growth rate of major cereals is far below the average population growth rate. In fact, Nepal is the only country in South Asia where population growth rate surpasses the growth rate of cereals, although Pakistan is near equilibrium (Figure 1.2). Growth rate of rice, maize, and wheat production in Nepal is the lowest in South Asia (Table 1.4). Yields of cereals in Nepal are comparable with the Indian state of Bihar, which shares similar agroclimatic conditions and cropping systems.

FIGURE 1.2—AVERAGE ANNUAL GROWTH RATES OF POPULATION AND CEREAL PRODUCTION IN SOUTH ASIAN COUNTRIES



Source: Cereal production data from FAOSTAT 2010; population growth data from World Bank 2010.

The combined impacts of stagnant economic growth (including agriculture), extreme variation in climatic conditions, and natural disasters have jointly contributed to escalating food prices and increased food insecurity (Nepal, National Planning Commission–WFP–NDRI 2010). The annual average price of food increased by nearly 17 percent in 2008–09 compared to a 10 percent rise in 2007–08. The price of some commodities, such as sugar and related products, increased by nearly 46 percent (NRB 2009). Food security in Nepal is characterized by considerable regional and seasonal variations. February to March and July to August, for example, are the hungry or agriculture-lean periods when people are unable to meet minimum nutrition and consumption needs over a sustained period of time. Chronic food insecurity often stems from extended periods of poverty, restricted access to resources, and limited or no assets. Because of the longer crop-growing season, hungry periods last longer in the hills and mountains than in the Terai (Nepal, National Planning Commission–WFP–NDRI 2010).

TABLE 1.4—AVERAGE PRODUCTIVITY OF RICE, MAIZE AND WHEAT IN SOUTH ASIA AND SOME OF THE INDIAN STATES

Country	Average productivity (t/hectare)		
	Rice	Maize	Wheat
Bangladesh	4.0	5.8	1.9
India	3.3	2.2	2.7
Nepal	2.7	2.1	2.2
Pakistan	3.3	3.4	2.6
Sri Lanka	3.8	1.8	
Bihar	2.1	2.3	1.9
Uttar Pradesh	3.3	1.4	2.7

Source: Country-level yields from FAOSTAT 2010; yields of Indian states from Ministry of Agriculture, Government of India.

Poverty and food insecurity are always interrelated. On the one hand, poor people lack the means to produce sufficient food or purchase food in the market. On the other, food insecurity can also lead to poverty when people have to borrow or sell assets in order to buy food.

The severity of hunger in Nepal is extreme. With its ranking of 20.6 on the 2008 Global Hunger Index (GHI), Nepal ranks 57th out of 88 developing countries and countries in transition. The highest prevalence of hunger can be found in the far- and mid-western hill and mountain regions. The Hunger Indexes (GHI) of 2008 in these parts of the country are close to, or above, 30, indicating an extremely alarming situation (Nepal, National Planning Commission–WFP–NDRI 2010). In fact, not a single sub-region in Nepal falls within the moderate to low hunger categories (WFP 2009). The situation had improved a little by 2011 as the GHI fell slightly to 19.9 (using data from 2004 to 2009). This gave Nepal a rank of 54th out of 129 countries and the hunger category was reduced to serious rather than alarming (IFPRI 2011).

Nepal's recurrent natural disasters, such as the Koshi floods of 2008, and floods in central and far western Terai in 2009 and 2010, have had an immense impact on crop production, livestock, and other productive and household assets. The disruption of market supply chains for long periods due to political unrest, *bandhs* (virtual closures of transport and business) and more localized strikes can also cause transitory food insecurity. Various risks jeopardize food and nutritional security and worsen vulnerability to food insecurity, including unfavorable geographic location, as well as social, economic, and cultural exclusion and inequalities (Nepal, National Planning Commission–WFP–NDRI 2010).

Whatever the case, the people of Nepal are known for their resilience. To cope with seasonal food insecurities, many people—mostly men—migrate to obtain temporary employment, leaving families behind with little to eat (Nepal, National Planning Commission–WFP–NDRI 2010).

In 2005, the government formed the Nepal Food Security Monitoring System (NeKSAP)[4] to monitor, collect, consolidate, and analyze food security data. It uses the Food Security Phase Classification approach to distinguish five phases of food insecurity to aid decision making (Nepal, National Planning Commission–WFP–NDRI 2010). In this way, the NeKSAP helps achieve coordinated, appropriate, and timely action to prevent human suffering due to food insecurity.

Background to the study and its purpose

Farmers' access to technology, technical knowledge, and institutional credit is severely restricted, particularly in the poorest and most food-insecure areas.One measure for increasing agricultural productivity would be greater application of modern technologies and inputs. Hence, this study analyzes the use of seeds, fertilizers, pesticides, and agricultural machinery with specific reference to three major cereal crops (rice, maize, and wheat). It seeks to understand how policies might be changed to promote the supply of these inputs.This study specifically addresses the following questions:

- What is the current structure and impact of the public agricultural research and extension systems in Nepal, and how do these public systems contribute to improving the ability of small-scale, resource-poor farmers to access new technologies?
- What is the current structure of the seed and agricultural inputs industry in Nepal, particularly with respect to competition and innovation?
- How does industry structure affect the ability of small-scale, resource-poor farmers to access new technologies?

4*Nepal Khadya Suraksha Anugaman Prarali* (NeKSAP), meaning Nepal Food Security Monitoring System, is institutionalized within the Ministry of Agriculture and Cooperatives (MOAC) at the district level. It falls under the strategic guidance of the Food Security Monitoring Task Force, which was established by the National Planning Commission. The NeKSAP is comprised of representatives from district-based organizations, including government, nongovernmental organizations (NGOs), and civil society.

- What policy options can be introduced to improve the ability of small-scale, resource-poor farmers to access, and benefit from, new technologies?

METHODS, SOURCES OF DATA, AND LIMITATIONS

The study was undertaken to understand the situation of agricultural input supply and associated policy regimes in the country using a combination of methods. Sources of data used in the study are given in Table 2.1.

TABLE 2.1—A SUMMARY OF DATA SOURCES USED IN THE STUDY

Method of study	Organizations as source of data and information and other past reports in the study				
	Gov-ernment agencies	Agrovets/ Cooperatives	Private companies/ NGOs	UN agencies and other international organizations	Projects
1. Review and analysis of policy documents					
Number of policy documents reviewed	10	n/a	n/a	3	n/a
Number of periodical report and other documents reviewed	12	0	2	2	3
Number of interna-tional documents and journal articles reviewed	0	0	4	12	0
2. Key informant consultation					
Number of key informants consulted	22	10	6	0	3
3. Field survey					
Number of vendors studied	n/a	49	11	0	0
4. Case studies					
Number of govern-ment line-agencies and vendors con-sulted	6	22	0	0	0

Sources: As indicated.
Note: n/a = not applicable.

The study mainly used three methods to collect and analyze the information:

- Review and analysis of secondary data and information, including (i) various policy documents of the Nepal government related to agriculture and (ii) reports and journal articles on related work in Nepal and internationally
- Field survey of vendors of agriculture inputs (Agrovets) and private seed companies using a checklist
- Case study of selected chronically food-deficit and food-insecure districts in the hills and mountains of Nepal

The authors reviewed and analyzed various policy documents related to agriculture research, development, and agricultural inputs in Nepal. This provided the basis for understanding overall agricultural policy regimes, their gaps, and deficiencies. They consulted with key people from the Department of Agriculture (DoA) and the Nepal Agricultural Research Council (NARC) within the Ministry of Agriculture and Cooperatives (MOAC) in Kathmandu Valley in

October and November 2010, as well as with a number of district-level practitioners in selected districts during November 2010. Farmers and private-sector organizations were consulted during the same period to get their perspectives on agricultural inputs and existing policy instruments, and to help set the overall framework for the study.

Field Surveys

Government departments and parastatals report only official sources of data. This creates a huge gap between official statistics and reality on the ground. Most of the agricultural inputs are dealt with by private-sector organizations, but none of these transactions are included in official government reporting. Not only are there gaps in data recording and reporting, but the reliability of data from government sources is often questionable due to a lack of scientific data-recording systems. The general tendency is to show an improved physical progress in terms of quantity and quality over previous reports (with the exception of a major census surveys).

To address these gaps in the available data sets, field surveys were undertaken. The surveys provide not only missing data in the government system, but also data not normally collected by government agencies, such as the informal flow of fertilizers from India. The survey identifies: the trend in the quantity of fertilizers coming informally from India; the actors involved in this trade; the modes of transportation used; and other related issues, including the possible involvement of government administrators, politicians and police from both countries in the trade.

The field surveys were done in 10 out of 20 randomly selected Terai districts since these districts are the formal and informal gate ways for any fertilizer and other agricultural inputs from India. It was also important to document the major trends in the non-regulated flow of fertilizers as most of it comes through the open border with India all along Terai districts. The vendors (Agrovets) who were surveyed from November 2010 to January 2011 were selected on the basis of whether they were involved in fertilizer trade. The same vendors were also interviewed about the supply of cereal seeds and pesticides.

All seed companies in the 10 randomly surveyed districts in the Terai were studied, as only 16 private seed companies were registered in the country at the time of study. The survey covered 11 out of the 16 private seed companies because most happened to be in the survey districts.

Information on agricultural machinery was collected mainly through secondary sources. However, in-depth interviews with scientists from the Agricultural Implements Research Centre (AIRC), NARC, and Ranighat Parsa district provided a great deal of valuable information.

Six hill and mountain districts were chosen for case studies (Figure 2.1). Of these, Darchula and Jumla represent mountain districts, while the remaining four are mid-hill districts. Darchula, Achham, Jumla, and Kalikot are among the least developed, remote, and vulnerable to food insecurity and also affected greatly by conflict. Sindhuli is also low on development indexes but better off in terms of food security; Palpa has quite high development indexes, including accessibility. Information collected from a sample of vendors—mainly Agrovets and fair-price cooperatives—formed the main source of information for the case studies in Palpa (six) and Sindhuli (four). Information was gathered from four vendors in Darchula and Achham and two vendors in Jumla and Kalikot.

The field surveys were done by staff of SUPPORT Foundation, one of CARIAD's collaborators. However, staff members of LI-BIRD and FORWARD (also CARIAD's collaborators) were also involved in a few instances. Surveys were arranged through partners mainly because these organizations had good rapport in the area and were fully aware of the situation related to agricultural input supply. The checklist and questionnaires were prepared for all the field surveys and shared with the International Food Policy Research Institute (IFPRI). All the enumerators were oriented on methodology and the checklist to be used in the survey. Data on the seasonal variation in the transaction volume and price of fertilizers were also collected.

After the draft report was prepared, certain sections of the document, where independent review was deemed important, were circulated to a selected professional for critical review. The section on agricultural machinery was reviewed by Dr. Stephen Biggs (ex Research Fellow East Anglia University, United Kingdom), and pesticides by Dr. Yubak Dhoj G. C. (Programme Director, Plant Protection Directorate, DoA) and Sharala Sharma (Senior Scientist,

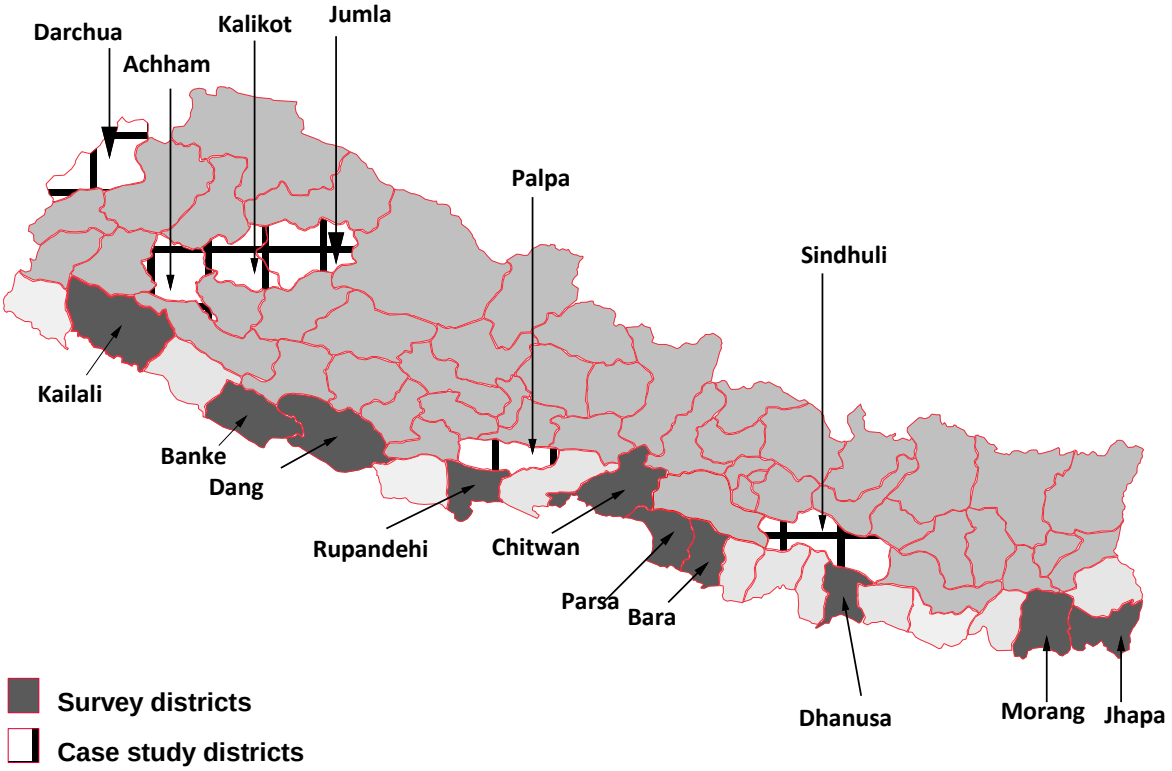
Plant Pathology Division, NARC). The draft reports on Agrovets and private seed companies were reviewed by Laxmi Kant Dhakal (a successful seed entrepreneur and vice-chairperson, Seed Entrepreneurs' Association of Nepal). All the comments provided by the reviewers were considered while revising the report.

Limitation of the study

The study heavily draws on secondary data and information mainly from government sources. Consequently, it only presents official transactions by government agencies and parastatals, alongside government positions, rather than realistic situations on the ground. In many instances, government departments, NGOs, and projects work with the same set of community-based organizations, while their physical progress on the same sector is reported separately. In this context, there is a danger of double accounting, particularly on statistics related to cereal seeds. The quantity of seed transactions reported for small seed enterprizes (SSEs), community-based seed producer (CBSP) groups, and District Seed Self-Sufficiency Programmes (DISSPROs) is one example.

Information related to the informal flow of fertilizers from India also needs to be interpreted cautiously; it presents more of a trend than accurate data. This is understandable since it is an informal and illegal operation. Many times respondents hesitated to share information about this trade. Once the study's objectives were shared with them, they were more comfortable responding to queries but often provided a range or just rough estimates.

FIGURE 2.1—DISTRICTS OF NEPAL WHERE SURVEYS WERE COMPLETED ON AGRICULTURAL INPUTS



Source: Produced by authors.

The wealth of information collected in this report will be useful as raw material for government planning, particularly for developing (1) a new Agricultural Development Strategy (ADS), (2) a national food and nutritional security policy (NFNSP), and (3) a new fertilizer policy.

ANALYSIS

In Nepal, farmers' access to agricultural inputs and modern technologies and technical knowhow is constrained. An analysis of these constraints can provide evidence for practical policy recommendations to the Nepal government, which is currently developing a new Agricultural Development Strategy (ADS) to replace the existing Agriculture Perspective Plan (APP). The analysis was done with reference to three major cereal crops (rice, maize, and wheat) in four subsectors (crop-breeding research and seed supply, fertilizers, pesticides, and agricultural machinery). It was designed to gain information on the research, development, and innovation system and on the role of policy and organizations in providing agricultural inputs and innovations.

This analysis addresses four major issues:

- The research and extension system and how it affects resource-poor farmers
- The structure of the seed and agricultural inputs industry
- How these industries allow small-scale, resource-poor farmers to gain access to new agricultural technologies
- The available policy options that could improve access of resource-poor farmers to new agricultural technologies

The study synthesizes information and data from several sources:

- Statistics published by government agencies
- Interviews with key actors in the research, extension and agro-industry sectors conducted in October–November 2010
- A field survey from November 2010 to January 2011 of 49 agricultural input vendors who sold fertilizer as part of their product range in 10 randomly selected Terai districts and all 11 registered private seed companies in these districts
- Six case studies in hilly and mountainous districts with four selected to represent chronically food-deficit districts and two selected to represent food-insecure districts

The public agricultural research and extension systems

Nepal's agriculture sector contributes to more than one-third of gross domestic product (GDP) but, over recent decades, agriculture development has failed to keep up with the increased demand from a growing population. In particular, the average annual growth in the production of the major cereals (rice, maize, and wheat), which are the staple foods in Nepal, is much lower than the population growth rate. Because of this lack of growth in agricultural productivity, Nepal already faces food shortages: 41 percent of the population consumed less than the minimum calorie requirements in 2010 (Nepal, Ministry of Finance 2010); 43 out of 75 districts are in food-deficit;and 10 are vulnerable to food shortages (NARC 2010). Rural poverty, food security, and agricultural productivity are closely linked: 78 percent of the population has an income of less than US$2 a day. Of these, 67 percent are smallholder farmers, while 11 percent are agricultural laborers. The rural poverty level of about 33 percent of people below the poverty line is 3 times as high as the urban poverty level (Gulati et al. 2010).

Agriculture research is an engine for agricultural growth if it generates and disseminates improved agricultural technologies that farmers can accept and that increase food production. Only if such technologies are widely used will they help increase production and farm incomes at a national level, and hence lower food prices for the food-insecure. Agricultural research will only achieve this impact if it is demand-driven (so that its research products meet the needs of farmers), and results-oriented (so that the new technologies are put into use).

The Nepal Agricultural Research Council (NARC) is the main agency responsible for agricultural research. In spite of a high degree of autonomy provided by its bylaws, political interventions greatly reduce its effectiveness. Private-sector companies and NGOs are also involved in agricultural research and extension, but on a limited scale. NARC's breeding programs are heavily dependent on introducing new crop varieties from the Consultative Group on International Agricultural Research (CGIAR) centers and other international crop research programs; the national research system has not developed sufficient research capacity of its own.

The Department of Agriculture is present throughout the country through its District Agriculture Development Offices (DADOs) and is the key government agency for agricultural extension. The extension system has changed from the "training and visits" system to its current supposedly "service on demand" approach, in which farmers are expected to visit the Agriculture Service Centers (ASCs) or Agriculture Sub-Service Centers (ASSCs) where the government agricultural technicians are stationed. However, on average, rural households require more than two hours to reach their nearest markets or government service centers because of difficult terrain and a lack of transport infrastructure (Nepal, National Planning Commission 2004).

Despite such difficulties, the case study in the hilly and mountain areas showed that DADOs were almost the only source of new seed varieties and technical knowhow. However, the stakeholders' comments revealed constraints other than travel:

- The unavailability of the technician when they visited
- The poor quality of inputs and services rendered by DADOs and their lack of timeliness
- Poor commitment of staff members to their work, management's failure to impose accountability, and poor monitoring of the work of the DADOs

There is a strong case for reviewing the current "service on demand" approach, particularly for remote and difficult areas because private-sector service providers provide a weak or almost non-existent alternative.

The involvement of NGOs in supporting agricultural development is common, mainly through extension and subsidized input supply in projects funded by donors. While few are also involved in agricultural research, they have made tangible contributions in participatory research and the scaling-up of its outputs, and hence have generated impacts on food security and productivity. However, this role in agricultural research and development may not be sustainable as most NGOs lack a continuing

source of funding. Sustainability can be provided only by a change in policy that allows the funding of NGOs through long-term, government-funded agricultural programs.

The seed and agriculture inputs industry

The Agriculture Perspective Plan (APP) was formulated in 1995, with its implementation starting in 1997, as a framework for accelerating broad-based agricultural growth to achieve food security and poverty alleviation. Most of the APP targets have not been met for a variety of reasons, including lack of coordination and resources. Its implementation focused on a "pocket package" approach where activities were concentrated in only a few pockets, mostly in high-potential production systems in the more accessible areas—that is, the Terai, low hills and valleys. This ignored the vast majority of small-scale, resource-poor farmers (smallholders) in the country. However, the government has recently begun to replace the APP with a new 20-year strategy—the Agricultural Development Strategy (ADS) (B. Aryal, pers. comm.). The new strategy is expected to be in place by 2013, nearly two years before the planned completion of the APP.

The more recent National Agricultural Plan (NAP), 2005, and the Three-Year Interim Plan (TYIP), 2007–2008, were both politically motivated policy documents. Their main features were broad-based economic growth by modernization and commercialization of agriculture, while addressing the issues of social inclusion by incorporating concerns of ethnic minorities and women. Again, none of the plans have been very effective for smallholder farmers as the programs were focused on high-potential production systems and accessible areas.

Research

Within all these plans, the Nepal Agricultural Research Council (NARC) is the lead agency for agricultural research in Nepal and mainly works with open-pollinated and inbred varieties of all the food crops. It has released 140 varieties of rice, maize, and wheat since the 1960s. Only 60 percent of currently released varieties are in demand for rice, and only one-third for maize and wheat. Farmers are overwhelmingly growing old and obsolete varieties of these crops: 85 percent of all the foundation seeds demanded for rice in 2010 were for varieties released before 1995; for maize the share was 75 percent; and for wheat, around 36 percent. A few private-sector maize hybrids (from Indian and Chinese companies) have been formally registered with the regulatory authority, although there has been a well-established informal trade in hybrid maize seeds. NARC has released only one hybrid maize variety through the National Seed Board (NSB). Private companies have also registered some rice hybrids with the NSB (L. Acharya, pers. comm.). No genetically modified (GM) cereal varieties have been tested or released in Nepal.

Seed industry

Until 1998, the formal seed industry, comprising the development of new varieties and the supply of source seeds, was almost entirely in the hands of the NARC. The National Seed Policy (NSP) of 1999 for the first time had a provision for private-sector involvement in crop-variety development and the seed trade. The policy opened up the possibility of research on transgenics—genetically modified organisms (GMOs)—following the establishment of biosafety rules and regulations. The Plant Variety and Farmers Rights Protection Bill (currently in Parliament) has a provision, for the first time in Nepal, for plant breeders' rights, and these will be compatible with international norms. The NSP also allows the use of data generated from participatory on-farm trials for the release or registration of crop varieties. This was in response to initiatives on participatory crop improvement and community-based seed production by nongovernmental organizations (NGOs) with international collaborators.

Two types of seed supply systems are prevalent in Nepal: the informal farmers' seed system, which supplies more than 90 percent of all the seeds used by framers in crop production (see Table 2.1), and the formal system, which supplies less than 10 percent. Official statistics for cereal seeds in Nepal reported only 4,000 tons per year (Gulati et al. 2010). This, however, is the amount for the National Seed Company Limited (NSCL) and does not take into account seed transactions by companies, cooperatives, and groups, some of which belong to the District Seed Self-Sufficiency Programme (DISSPRO), that are registered with their local DADO (Table 2.1). The performance of

the formal, largely public-sector, system has been poor, but recently private seed companies and small seed enterprises (SSEs) have been emerging as important actors for food-crop seeds.

TABLE 3.1.SEED SUPPLY BY VARIOUS ACTORS OF CEREAL SEED INDUSTRY IN NEPAL, 2010

Indicator	Seed supply		
	Rice	Maize	Wheat
Area (million ha)	1.55	0.82	0.73
Total seed requirement (t)	93,000	20,000	87,600
Supply by National Seed Company Ltd. (%)	0	0	4
Supply by 11 private seed companies (%)	2	2	2
Supply by cooperatives and groups (%)	3	7	2
Farmers' own seed (%)	96	92	92

Sources: Data for area, total seed requirement, and supply by NSCL are from national statistics (NMoF, 2010); data for supply by private seed companies, cooperatives, groups, and farmers themselves are from surveys conducted for this study.

Note: Throughout the document, “t” refers to tonne.

Some recently established seed companies also have research components. Private companies from the neighboring countries of India and China have already registered hybrid maize and rice varieties with the National Seed Board (NSB) Nepal to market seeds in Nepal. This indicates that the environment for competition and creation of crop innovations is becoming more favorable. However, it remains to be seen how well these new varieties cater to the needs of smallholders. Cereal seeds for open-pollinated varieties (OPVs) of maize and inbred varieties of rice and wheat are not commonly imported from India.

DADOs make the most officialdemands (called indents) for foundation seed across the three major cereals, although the private sector is the most important for rice; DADOs are the sole actor in the mountainous region, and the most important one in the hilly region. Private-sector organizations are concentrated in the Terai where business opportunities are better, while DADOs provide source seed in the difficult and remote areas.

Private organizations from just a few districts placed most of the indents for foundation seed for the Terai. These districts were Dang, Rupandehi, Chitwan, Rautahat, and Sunsari, demonstrating their emerging importance as centers for seed production.

Fertilizer supply

Until 1997, the supply of subsidized fertilizer was entirely a public- sector responsibility. In that year, the Nepal government decided to deregulate the fertilizer trade and open it to private-sector participation. The Fertilizer Control Order 1999 and National Fertilizer Policy 2002 provided a regulatory framework for the liberalization of this essential commodity. For a variety of reasons, deregulation did not have the desired effect in improving fertilizer supply and hence the policy had no impact on agricultural production and productivity. Not only is there an acute shortage of fertilizers in the country, the deficiency of major nutrients, such as phosphorus, is becoming evident in areas with higher cropping intensities. This is mainly because farmers do not use balanced dosages of plant nutrients.

After withdrawing its fertilizer subsidy from 1997 to 2008, the government reverted to subsidizing limited quantities of fertilizers in 2009; once again, it made the National Fertilizer Company Limited (NFCL) the sole importer and distributer of such fertilizers. There is a big mismatch between the estimated current fertilizer demand of 586,000 tons annually and supply by NFCL of 100,000 tons in 2009–2010 and around 180,000 tons in 2010–2011. Nepal is in a dilemma in terms of fertilizer supply. Policy analysis in the past (ANZDEC 2002; IDL Group 2005; Thapa 2006) indicated that Nepal would need US$41 million annually to subsidize fertilizer purchases, which is a substantial amount. Nonetheless, the Nepal government provides a huge subsidy (US$170 million) on petroleum products (diesel, petrol), sometimes even by drawing on the development budget, but this subsidy is largely enjoyed by the urban elite (D.B. Chhetri pers. com 2011; Sharma 2011; Ghimire 2011). Similarly, the Nepal government provides US$25 million to World Food Programme (WFP) Nepal to support 1.8

million people across the country through a range of programs focusing on preventing hunger and meeting food and nutrition needs (WFP 2011). The existence of these large subsidies makes it more difficult for the government to find resources for a fertilizer subsidy (or for other inputs such as seed), even though this would be more equitable (as it would improve agricultural productivity and reduce external food supply and stabilize food prices). However, one can argue that $4.1 million funds can be found by revisiting overall subsidy regime of the government and by restructuring and privatizing the import of petroleum products which is the major factor affecting development budget.

Official statistics based on aggregate/national-level statistics put fertilizer use as low as 19 kg per hectare per year (Gulati et al. 2010). Fertilizer-use level in Nepal falls far below than that of other South Asian countries, which range from 136 kg per hectare (India) to 295 kg per hectare (Sri Lanka), (Gulati et al. 2010). Comparing these figures with neighboring states of India would be a more relevant comparison, but reliable data are not available. The Ministry of Agriculture and Cooperatives (MoAC) has no system of regularly collecting farm-level data on the use of fertilizers. Citing 2001 data from the Central Bureau of Statistics (CBS) in a study commissioned by Nepal's Ministry of Finance, Thapa (2006) reported the average use of fertilizers in Nepal in 2004–2005 to be 125 kg per hectare. Nepal's Fertilizer-Use Baseline study reported that the average nitrogen–phosphorus–potassium (NPK) nutrient application-rate on cereals in 2001–02 was 63 kg per hectare (Agrifood Consulting International 2003).

In 2009, a large, randomized survey of more than 1,600 households in 18 districts of the Terai found entirely different patterns of fertilizer use in Nepal.[5] For example, the average use of fertilizers in rice was 206 kg per hectare, in maize 204 kg per hectare, and wheat 194 kg per hectare (the UK DFID Research into Use Programme). In addition, the study also found that sampled households were using on average 11 tons per hectare of farmyard manure on all three cereals. These fertilizer figures seem more than reasonable. To support a rice yield of 3 tons per hectare, 100 kg nitrogen is required. To support the national average rice yield of 2.7 t per hectare, 90 kg nitrogen per hectare is needed.

These farm-level data show much higher fertilizer use than other studies that relied on secondary statistics from government sources. The higher use is probably because it takes into account both officially obtained fertilizer and also that informally imported from India. In the survey of agricultural input vendors, 60 percent of fertilizer sold had been imported unofficially. The proportion of unofficial imports is even higher when fertilizers are directly imported by farmers rather than passing through Agrovets[6], and when other private fertilizer dealers are taken into account.

Those involved in this unofficial trade were private fertilizer dealers (bulk suppliers), Agrovets, and individuals (including politicians) bringing fertilizers into the country using a variety of means of transportation, but the bicycle was reported to be the most important. Trucks, motorcycles, and four- and two-wheeled tractors were also used. Spurious fertilizers are a common occurrence when imported informally from India as it is impossible for purchasers to complain about a product that is imported illegally.

Case studies from six selected districts (four chronically food-deficit and two food-insecure) in the hilly and mountain regions, where more than half of the population are poor (Nepal, National Planning Commission–WFP–NDRI 2010), showed the supply of fertilizer (as well as improved seed and pesticides) by the private sector, AICL, and NFCL to smallholders was woefully inadequate. Fertilizers were not available when needed and never in quantities sufficient to have a visible impact on overall agricultural production. Even delivery by the World Bank–funded Nepal Safety Net project was unable

[5] A baseline survey covering more than 1,600 randomly sampled households from 180 wards of 90 village development committees (VDCs) of 18 Terai districts was done in 2009. For the survey, VDCs were randomly drawn to represent three agroecological categories based on drainage patterns, moisture regime, soil fertility, and crop productivity patterns from north to south, representing uplands, medium lands, and low lands. In addition, at least one group discussion was conducted at each participating VDC to triangulate results from household surveys (LI-BIRD-FORWARD-SUPPORT Foundation-CARIAD 2011).

[6] Agrovets refer to private entrepreneurs in Nepal that deal with agricultural inputs and veterinary medicines

to meet modest targets. For example, of the 74-ton fertilizer-supply target for Manang district, only 13 tons were delivered, and there was a complete failure to deliver the targeted 8 tons of improved crop seed (Tiwari, 2010).

Pesticide supply

All told, 97 pesticide suppliers have been registered with the Plant Protection Directorate (PPD). Pesticides are distributed through a large network of Agrovets —around 2,000 (including non-registered ones)—located in the Terai and more accessible areas in the hills (Nepal, Ministry of Agriculture and Cooperatives 2009). There is high competition in the sale of pesticides. The use of pesticides is increasing in the Terai and more accessible areas, while smallholders had a limited access to these inputs in the hills and mountains.

There is also a lack of proper mechanisms in place for the safe handling of hazardous chemicals. The survey of vendors found 60 percent of people engaged in the pesticide business had no technical background to handle pesticides, but many of them were giving advice to farmers. Although, study by Nepal Economic Agriculture, and Trade (NEAT-a United States Agency for International Development (USAID) funded project report that people running Agrovets and agro-dealers are educated (NEAT, 2011) (which is true for town centers and market places), however, majority of those operating in the rural areas are neither run by educated people nor are registered.

Discussion with the Agrovets and other vendors revealed a lack of regular coordination with concerned lineagencies and vendors. This related particularly to keeping vendors up to date on government policy for import and trading of pesticides and on newer and safer pesticides.

Private-sector agencies, particularly Agrovets, are the major players in the trade of pesticides, micronutrients, other agrochemicals, and in advising on their use. However, the majority of vendors do not have an agricultural science background so the content and quality of information passed on to clients with regards to pesticides is probably poor. Areas of great concern include a lack of knowledge about the quantity of pesticide used per unit of water, a safe waiting period, and safety measures during the storage, application of pesticides. The source of information used by vendors to pass on to clients was reported as largely coming from their own experience—which could not possibly cover the range of products actually supplied—rather than from credible sources such as DADOs or manufacturers. This may have far-reaching consequences in terms of correct use of pesticides, their effectiveness, and impact on the environment.

There is, hence, strong evidence of the need for capacity building of people on safe handling of pesticides and other agrochemicals particularly for those who are in the trade but do not have relevant qualifications. Reviewing the criteria for issuing new licenses to trade in pesticides may also be important. To address this, PPD is making a 35 days intensive training mandatory for those who are interested to start business on pesticides. Training covers the entire aspect of import, safe storage and application of pesticides before a trading license can be issued (Yabak Dhoj GC, pers. comm.). Similarly, coordination between the concerned government line agencies and the vendors while importing the pesticides is important to ensure that safer pesticides are brought into the market. There were also cases where the pesticide content in the consignments did not conform to the weight stated on the label. Both vendors and clients were fully convinced about the need for strong quality monitoring mechanism by the responsible government line agencies.

There is a clear lack of a recording system for these potentially hazardous chemicals in terms of storage, sale, and use. It was beyond the scope of this study to compile complete records on the pesticides in Nepal. It is possible to trace legally imported pesticides through records in customs offices, but this will not provide the complete inventory. Although the PPD has recently started documenting the various pesticides imported in the country, it is far from being complete (Nepal, Ministry of Agriculture and Cooperatives 2005). In the absence of such records, not much can be said about whether demand matches supply, and whether farmers in Nepal are benefiting from recent advances in this area of science.

During the discussion with the PPD, it was learned that Nepal does not have a pesticide accreditation laboratory and the required human resources to analyze pesticide residues. The PPD saw this as one of the constraints for the national programs to comply with international treaties and conventions signed by the Nepal government. This has also adversely affected the export of high-value crops and other agricultural commodities.

Rural and agricultural mechanization

There has been considerable progress in agricultural mechanization in Nepal with various types of machinery being adopted, primarily through imports by the private sector and its engagement with farmers. Most agricultural mechanization is taking place in the Terai and, to a lesser extent, in the lower hills and valleys. There are suppliers of all major makes of tractors, power tillers, and pump sets in Nepal. The machinery-supply industry is becoming more competitive as the number of actors increases along with the demand for machinery. However, there is a lack of policy to support agricultural mechanization. On the contrary, some government policies have had a negative effect on the development of local manufacturing, such as a high duty on importing raw materials needed for local manufacture of agricultural tools and machines.

Agricultural machinery is having a positive impact on smallholders since small-scale threshers, pump sets, and tillage equipment are now more widely available, less expensive, and suitable for smallholders. Smallholders can also avoid capital investment as, increasingly, Nepalese machinery owners provide custom hiring machines particularly tillage equipments, threshers and combine harvesters. Custom hiring by Indian business people in declining more recently, although, there is a legal provision to pay a daily customs duty during the temporary import of machines.

In the hills and mountain districts, mechanization is low given the difficulties of transporting heavy machinery and using it on small terraces. The predominant service providers for agricultural hand tools are DADOs, which procure the tools on demand for farmers. The private sector is almost nonexistent in the mountain districts and thin in the hilly districts.

Increasingly, Nepalese agriculture is facing a shortage of labor as a result of outmigration of youths in search of employment opportunities. This is also partly due to the lack of attention in reducing drudgery in agricultural and rural operations for poorer farmers and laborers. This labor shortage has had a distinct influence on the mechanization of agriculture in Nepal, which has accelerated in the last two decades. Several power-operated agricultural machines are now in use in Nepal (Biggs and Justice 2011), 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.

Some agricultural mechanization had begun in Nepal in the 1960s and 1970s with the introduction and promotion of four-wheel tractors (4WTs) on the Terai (Pudasaini 1976). This could be attributed to government- and donor-supported policies, as well as to the interest and engagement of the private sector in bringing in machines for agricultural use. Mechanization technologies and machines available across the long open border with India greatly influenced mechanization patterns in the Nepal Terai (Biggs et al. 2011).

Two-wheel tractors (2WTs) were promoted during the mid-1970s and early 1980s, with two Japanese aid programs importing approximately 2,000 tractors. Initially, the spread of 2WTs was limited to the Kathmandu and Pokhara Valleys, where they were used for transport and tillage. Further registration of two-wheelers was banned in both valleys as the vehicles were contributing to growing traffic congestion. One can still see some of the 2WTs in use even 30 years after their first introduction in Nepal (Biggs et al. 2011).

Minimum tillage by power-tiller drills has been popular among small- to medium-farmers as the drills perform 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. Minimum tillage by participatory technology development has produced an extra 600 kilograms per

hectare mean grain-yield of wheat compared with typical yields based on farmers' practice (Manandhar et al. 2009; Pariyar et al. 2001).

From the 1970s onwards, all the major Indian tractor companies established sales agencies across Nepal. The latest are multinational companies such as John Deere and New Holland, which have manufacturing bases in India. Current estimates of the total number of tractors are 42,000, with 30,000 (71 percent) four-wheelers and 12,000 (29 percent) two-wheelers. Many business people and engineers feel the demand will continue to grow as high as 40,000– 50,000. Despite the ban still in place in the Kathmandu and Pokhara Valleys on 2WTs, the growth in these peri-urban areas continues: farmers and other rural entrepreneurs who own the vehicles evade bans by registering their tractors in other places (Justice and Biggs 2011).

Trailers are an important feature for improving the income-earning potential of tractors. Tractors are used for three–six months a year in agricultural work, but in rural and peri-urban areas, tractor-trailers generate much work for hauling and transport. Justice and Biggs (2011) indicate a lack of statistics on the number of trailers, but estimate nearly 80 percent of owners of 2WTs in Nepal also own a locally manufactured trailer (9,600 tractor-trailers).

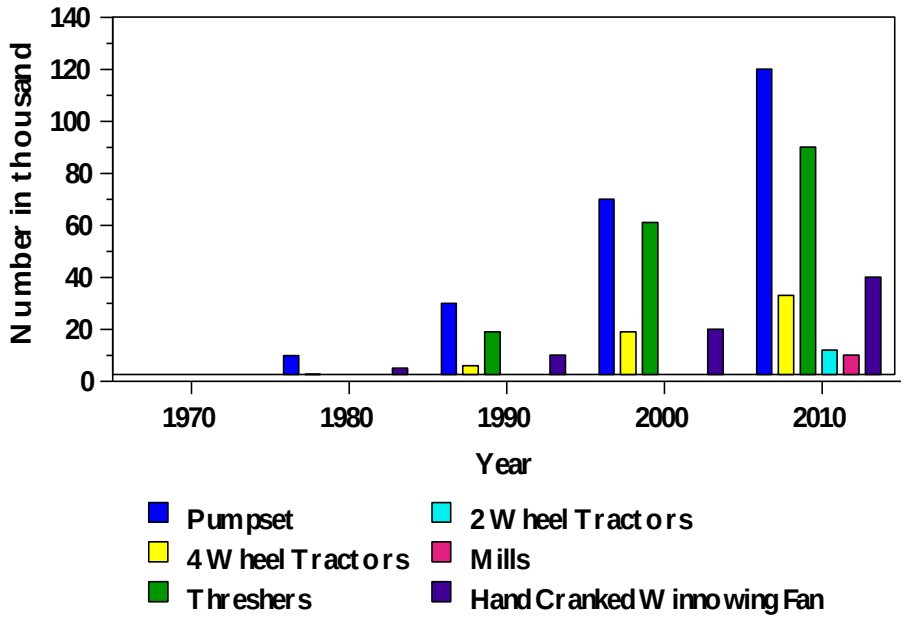
From the mid1990s on, large Indian combine harvesters were seen in Nepal, and today many Nepali combine owners and also Indians work on a contract basis in various districts in the Terai, majority of which are concentrated in Rupandehi, Bara, Parsa, Rautahat, Kapilvastu and Kailali districts. According to the NARC Scientist of AIRC Ranighat, Birganj, the machines are popular because they halve the costs of harvesting and threshing (G. Sah, pers. comm.). Small field sizes and maintenance problems are the major constraints to increased use of combine harvesters.

Both wheat and rice threshers are becoming popular in most parts of the Terai because farmers see a clear advantage in terms of saving time, resources, and labor. The use of machines to thresh wheat is much higher than for rice, although rice threshers are beginning to spread in Nepal's eastern Terai. These are generally powered by the diesel engines of pump sets of Indian and, increasingly, Chinese origin.

At present, only 17 percent of the total cultivated area has year-round irrigation, while 42 percent has irrigation of some sort. In the Terai, out of 889,000 hectares of irrigated area, 82 percent is covered by surface irrigation and the rest by ground water (tube wells) (Nepal, Ministry of Energy 2002). The agricultural census reveals that 14 percent of holdings in the Terai use pump sets for pumping water mainly from shallow tube-wells. Indeed, water-lifting machines have one of the fastest growing adoption rates (Fig. 3.1). Farmers now have access to small-scale irrigation technologies such as Chinese pump sets, lay-flat pipes and the custom hiring of irrigation services. These are helping to alleviate the effects of more unpredictable and erratic rains, and more frequent long dry spells. In general, five-horse-power pump sets are the most common, and farmers prefer water pumps made in India for their durability, availability of spare parts, and convenience of repair and maintenance services. Chinese water pumps are also becoming popular as they are cheaper to purchase or custom hire. Another contributing factor to the adoption of pump sets may be subsidies for them, and subsidies for the use of electricity. There are now at least 100,000 small-scale irrigation pump sets in use. In addition, more than 100,000 treadle pumps have been installed by small farmers for irrigating mainly vegetable crops in the Terai.

Pump sets are the most popular agricultural machinery in Nepal followed by threshers and winnowing fan. Use of four-wheel tractors is as long established as pump sets, but their growth has been rather slow, probably due to high demand for capital. Around 15–20 percent of tillage is now mechanized, largely by four-wheel tractors. Two-wheelers have been around since 1990, but have been increasing considerably in number only over the last decade (Fig. 3.1). Another striking change is the growth of processing mills in the last decade. In addition, the rapidly growing horticulture, poultry, dairy, animal-feed and other "value-added chain" industries, based on agricultural and other rural resources are using mechanical equipment of one type or another in production, processing, transport, and marketing activities.

FIGURE 3.1—SPREAD OF AGRICULTURAL MACHINERY, NEPAL, 1970–2010



Source: Adapted with permission from Justice and Biggs, from a forth coming book on agricultural mechanization to be published by FAO.

Using drip irrigation technology, fields can be irrigated with less water, making it more effective in areas having water scarcity. It has been very successful in hilly regions and the northern belt of the Terai region.

To date, more than 189,000 biogas plants have been installed with more than 95 percent in operation. Favorable policies for subsidies, public-private partnership, comprehensive quality standards, and a strong monitoring mechanism are the major pillars of this program. More than 66 percent of biogas plants are connected to toilets. Biogas is widely recognized as a sustainable and clean energy source to improvethe quality of life and protects the environment (Manandhar et al. 2009).

An improved water-mill program is being implemented in 16 hill and mountain districts of Nepal through 16 service centers and eight Ghatta Owners' Associations.[7]By the end of June 2007, the program had helped install more than 2,700 improved water mills. Of these, the vast majority is of short shaft and used for efficient grinding; about 300 units are of long shaft and used for other purposes such as rice mills, saw-mills, oil expellers, *lokta (Daphe spp.)* [8] beaters, and *chiura* (beaten rice) making. The improved water mills have replaced diesel-powered mills and, hence, contribute directly to reduced carbon dioxide emissions, saving on scarce foreign exchange to import expensive fossil fuels and reducing dependency on them.

Gravity ropeway technology was transferred from northern India to Nepal in collaboration with the International Centre for Integrated Mountain Development (ICIMOD) and private manufacturers/suppliers. An initial study showed that the gravity ropeway system reduced transportation costs of agro products by at least half. It gave villagers the confidence to supply vegetables, milk, and other perishable agricultural and forest products in larger amounts and to enter the competitive market in cities. It also improved socioeconomic conditions (health, education, and convenience), created employment opportunities, and supported the business of local manufacturers and service providers (Biggs and Justice 2011).

Some agricultural machinery developed by NARC's Agricultural Engineering Division (AED)—hand maize sheller, coffee pulper, thresher-cum-peeler for millet, and low-cost solar dryers—are commer-

[7]*Ghatta* is a traditional water mill used for milling cereal grains.
[8]Lokta (*Daphne* spp.) is an endemic plant bark which is used for making Nepali paper.

cialized and adopted by farmers in various parts of Nepal. The hand maize sheller reduces drudgery for women farmers. The coffee pulper has been adopted on a commercial scale at the community level, and has increased capacity and efficiency by 50 percent compared to manual operations related to these commodities (NARC 2004).

The Agricultural Engineering Unit was established in 1953 under the Ministry of Agriculture to develop infrastructure, farm buildings, farm roads, and irrigation facilities in various newly established agricultural farms and stations. Later, its role was redefined to develop appropriate technologies in agricultural engineering for various agroecological regions of the country.

The Agriculture Implements Research Centre (AIRC), also known as Agricultural Research Station–Agriculture Implements) Ranighat, was established in 1965. It is responsible for designing, testing, modification, and promotion of various types of tools and equipment.

The Agricultural Tools Factory (ATF) was established in 1968 and was later privatized due to its poor performance as a public-sector organization. As a private company, it was constituted with 65 percent private shareholding and 35 percent shareholding from the Nepal government. ATF performed only for about six months after privatization and then it stopped functioning for various reasons (Adhikary 2003).

Mechanization will become more important in addressing the emerging issue of all the young men who have migrated out of the rural areas. With male outmigration, women may become more responsible for making on-farm production decisions. This suggests the need for targeted interventions to address rural women's needs, for example, special credit programs to help rural women purchase small-scale tractors and pump sets (Manandhar et al. 2009).

NARC scientists and staff working in the engineering workshop revealed in discussions that many of the tools and machines developed by NARC were still on the shelves due to lack of a favorable policy for enterprise and marketing. NARC stations do not have a mandate to produce and sell tools and machines on a large scale—their role is limited to research. Local manufacturers are de-motivated, as there is a high customs duty on importing raw materials for manufacturing. Conversely, all kinds of tools and machines that are ready to use are exempt from customs duty. Hence, engineering firms are not interested in commercializing NARC prototypes, and small holder farmers and other stakeholders have not benefited from these interesting and potentially useful innovations.

Since the late 1990s, there has been collaborative research between NARC and CGIAR centers (particularly CIMMYT and IRRI) to develop conservation-agriculture (CA) technologies with the National Wheat Research Programme (NWRP), AIRC, and other NARC Centers. More recently, 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, and are sustainable and environmentally sound. As important interventions, CSISA chose the laser land leveler (LLL); direct-seeded rice (DSR); zero tillage on wheat, maize, and lentil crops; un-puddled transplanted rice (UTPR); and reduced tillage (RT) on wheat, lentils, and winter maize after rice.

Currently, two units of laser land-leveler have been introduced and are in operation. Apart from LLL, the project also introduced multi-crop seeders for rice, maize, wheat, lentils, kidney beans, and barley. The Turbo Happy Seeder was mentioned to be particularly suitable for plots that use combine harvesters; the seeder is designed to chop straw that is quite long and spread on the ground (D. P. Sherchan, pers.Comm.).

However, since many rural engineering innovations are already spreading in use, and have been tested against the harsh economic and technical realities in contrasting areas of Nepal, it would be best to assess if, and where, these CSISA interventions are already in use.

At Ranighat, in the Terai, a long-term experiment is assessing the relative advantages of the raised bed over the flat-bed system for rice, wheat, and mungbean. It includes experiment with and without mulch (rice straw for wheat, and wheat straw for rice and mungbean) in terms of net return per unit area, as well as long-term sustainability of cropping patterns. Direct seeding is done for all the three crops. Reshaping of beds is done after rice, as some of the soil from the beds also goes down to the furrows.

Preliminary results suggest that raised beds with mulch gave much higher combined yield and returns compared to flat beds with or without mulch. Weed suppression, moisture conservation, and possibly the addition of extra organic matter to the soil through mulch may have contributed to this increased yield and returns compared to no mulching. According to the NARC scientist at AIRC, Ranighat farmers consider raised beds less user-friendly for crop production; according to them, this is a tedious method as it requires planting on the rows remaking the beds, and use of zero or minimum tillage every year, for which they may not have access to necessary tools and machinery.

Capacity building of in-country agro-related metal works industries

Local manufacture is crucial for the growth and development of agricultural mechanization. Manandhar and Adhikari (1999) estimated that more than 85 percent of hand tools and implements are made by local artisans (blacksmiths and other people engaged in this business). However, such artisans are often poor, illiterate or poorly educated, socially excluded (particularly in the case of blacksmiths), and lack any access to new knowledge and technologies and financial resources. Therefore, modernization of this important trade is yet to be achieved. These constraints could be removed by training artisans in manufacturing skills development and business development skills following the model used in the development of small seed enterprises (SSEs). Other lessons from the SSEs also apply, such as the need for support for working capital—in this case to avoid the usurious interest rates of money lenders—and the development of cooperatives.

Lack of technical and safety standards

Although NARC is involved in the development and testing of new prototypes of agricultural tools and machines, there is no institution responsible for overseeing quality control, standardization processes, and safety measures. As a result, there have been several accidents while operating agricultural machinery. Enforcing quality and safety standards on agricultural machinery production and import are vital (G. Shah, pers. comm.).

Focus on creating awareness about agricultural mechanization

Unless farmers and other entrepreneurs know about new tools, equipment, and machinery and their roles to improve livelihoods, it is unlikely they would adopt those technologies. Therefore, knowledge about agricultural machines and associated technologies and their potential contribution in poverty reduction should reach clients in the grassroots. Several studies on seed flow indicate that knowledge about the seeds travels far ahead of the adoption of new crop varieties (Witcombe et al. 2008), and this concept would also fit in the process of other technologies, including agricultural tools and machines. However, since these are more resource-intensive than other agricultural inputs, it would need more awareness creation and flexibility—such as custom hiring for smallholders—to be able to use them.

Extension and promotion of agricultural machineries are currently weak in Nepal mainly due to lack of an organizational set-up and the necessary human resources. The Directorate of Agricultural Engineering (DoAE) was recently established with limited human resources for the dissemination of technologies. The extension of its presence to the district level in all the DADOs would improve access of farmers to these technologies. Although the testing and promotion of agricultural tools and equipment and associated technologies are taking place at the outreach sites of NARC, these activities are limited. They need to be made more participatory and client-oriented so NARC can learn which ones should be promoted, and so farming communities can learn more easily about new technologies and innovations, and then adopt them.

Inadequate facilities for service, repair, and maintenance of farm machinery; lack of availability of spare parts; and lack of training on operation and maintenance of farm machineries are also constraining growth of this industry.

Lack of rural infrastructure, particularly roads, is a major obstacle for the overall development of agriculture, including mechanization and market networks. Interestingly, in Bhutan, there is an integrated program of cheap rural roads for two-wheel tractors (2WT) as the transport device; the 2WT is also seen as a method to supply tillage and other services, such as haulage during slack periods. However, infrastructure development is also an important part of a wider national strategy for economic development, including agricultural mechanization. The failure of Nepal's public sector to develop rural infrastructure, which was also on the priority list of APP, has adversely affected overall growth, including the process of mechanization. This is a higher-level policy issue outside the scope of this paper, but the need for concerned agencies to address this is beyond doubt.

Focus on small-scale machinery and custom hiring

There are strong arguments for the government to promote small-scale machinery in Nepal when the examples of China and Bangladesh (described below) are considered. This case is strengthened by the small landholdings and difficult terrain in most of Nepal, which would seem to particularly favor small-scale machinery. There needs to be a policy on how best to supply small-scale machinery to smallholder farmers.

Small-scale machinery is not always the best choice. Large size machinery for threshing in the Terai for example is the best technology and custom hiring of such expensive machinery is the only viable economic option for the vast majority of farmers. In the past, this business (custom hiring of large equipments) was dominated by Indian machine owners but more recently, increasingly, Nepalese machine owners custom hire equipments for tillage, harvesting and threshing. There is a need to develop and implement an appropriate policy to facilitate custom hiring for the wider benefit of smallholders.

Biggs et al. (2011) and Justice and Biggs (2011) cite examples from China and Bangladesh in favor of small machinery. In China, the government initially prioritized the production of small horsepower pumpsets and tractors at a lower level of technical efficiency, and a significantly lower cost than elsewhere. Lower-quality Chinese equipment turned out to be good enough to meet the basic economic and technical needs of two groups: small farmers with fragmented plots, and small-scale entrepreneurs who bought equipment to hire out as part of the increasing growth of rural agricultural service industry (Qiuqiong et al. 2007).

Small-scale equipment entered Bangladesh in the 1990s following a major change in policy in the late 1980s resulting from the national food crisis. This change in policy combined with market liberalization, and lowering of tariffs resulted in massive imports of small pump-set engines for irrigation; later, 2WTs and other equipment mainly powered by small-scale and cheap Chinese diesel pump-set engines also arrived. It gave Bangladesh possibly the most mechanized and labor-intensive agriculture sector in South Asia with substantial employment and growth linkages to rural and urban sectors (Biggs et al. 2011a, Justice and Biggs 2011).

The situation in India stands in striking contrast to that of China and Bangladesh**.** In spite of India being the number one producer of 4WTs in the world, only 22 percent of its area is under mechanized tillage (Kulkarni 2009) compared to 80 percent mechanization in Bangladesh and Sri Lanka (Biggs et al. 2011b). This may be due to a small number of 2WTs—110,000, a third of the number in Bangladesh. Variation in mechanization between Indian states has been attributed again to government policy that favors large equipment.

Policy gap

It appears that not only there is no agricultural mechanization policy, but some government policies to address wider issues are counter productive. For example, the heavy duty on importing raw materials for construction and manufacturing has created a disincentive to all local engineering firms to engage in local production and sales of tools and equipment. On the other hand, imported ready-to-use

machinery that does not attract the same duty is not always suitable for smallholder farmers and the farming situations in the hills and mountains. One option could be to provide tax relief to local engineering firms and equipment manufacturers for the import of raw materials used for manufacturing agricultural machinery.

There are a number of engineering workshops/metal craft workshops, mainly concentrated in the Terai, that are also involved in manufacturing agricultural tools, equipment, and machinery. They cannot survive on the business of agricultural tools and equipment alone so most have diversified to include non-agricultural manufacturing, which forms the major part of their production and sales.

There is a lack of reasonable support by government for agricultural mechanization. Conversely, in Bihar, India, farmers get a 50–80 percent subsidy on various kinds of machineries (G. Sah, pers. comm.).

The public sector could fund some low-cost research to find out what rural mechanization already exists in farmers' fields, how mechanization processes are taking place, and who appears to be getting the benefits and why. The study would determine what processes for rural mechanization need to be promoted to help reduce rural poverty and increase worthwhile rural employment. It may well mean, say, the promotion of two-wheel tractor programs by offering credit to small farmers, who then hire the vehicles out to others for transporting or threshing grain, etc.

Another opportunity highlighted in policy analysis on agricultural mechanization is to link this sector with occupational caste of Nepal to improve livelihoods and reduce poverty. This will help generate employment and poverty reduction in rural areas by engaging liberated *Haliyas*[9], particularly *mi*[10]and*Luhar,* in manufacturing agricultural tools and equipment and helping to establish their cooperatives for the sale of such machinery. Favorable government policies (whether direct or indirect) are vital for the promotion of agricultural mechanization. Research and development on agricultural mechanization would need to be participatory and client-oriented so that appropriate farmer-friendly tools, equipment, and machinery could be developed and promoted.

Industry structure and access to new technologies

Most Agrovets (nearly 90 percent) are situated in the Terai and accessible areas in the low hills. The key informant survey with Agrovets in the Terai districts revealed no difference whatsoever in the access of farmers in different wealth categories to input suppliers. Small- and medium-sized farmers constituted nearly 84 percent of all Agrovet customers (63 percent medium and 21 percent poor). These figures largely agree with the official figures that 75 percent of all holdings are of less than 1 hectare of land. Most farmers (86 percent) accessed inputs from an Agrovet located within 15 km of their farms.

The presence of private-sector agricultural inputs and service providers in the remote rural areas is almost non-existent. This is evidenced by the case study from the hills and mountainous districts, and an analysis of the organizations that placed demand for source seeds of three major cereals. Whenever Agrovets and other private-sector agencies are present in the hills, they are limited to the district headquarters for the obvious reason that there is an inadequate volume of business in rural areas.

The overall industry structure can be summarized with the help of the following matrix (Table 3.2). It clearly demonstrates the public sector is still a major player for agricultural research, extension, and seed supply both in accessible areas and remote regions. Private-sector actors are slowly becoming important players in accessible areas for most agricultural services, except research and extension. There is a lack of competition and plurality when one considers all the agroecological regions and service areas.

[9] *Haliyas* are traditionally bonded plowmen from the *Dalit* families responsible for all plowing works in the hills for so-called upper-caste people. All families with such arrangements have been liberated by a government order without proper arrangement for their settlements and livelihood securities.

[10] *Kami* and *Luhar* are an occupational caste mainly responsible for making agricultural tools and equipment.

TABLE 3.2.INDUSTRY STRUCTURE IN NEPAL IN RELATION TO SEED AND AGRICULTURAL INPUTS

Region/agricultural services	Involvement of different sectors			Overall structure	
	Public	*Private*	*Civil Society*	*Degree of competition*	*Plurality*
Terai, river basins and low hills (< 1,000 m)					
Agricultural research	High	Low	Medium	Medium	High
Agricultural extension	High	Low	High	Medium	High
Seed supply	Medium	High	Medium	High	High
Fertilizer supply	High	Medium	None	Low	Low
Pesticides supply	Low	High	None	Low	Low
Machinery supply	Low	High	Very low	Low	Low
Hills and mountains (> 1,000 m)					
Agricultural research	High	Low	Medium	Low	Low
Agricultural extension	High	Low	High	Medium	Medium
Seed supply	High	Low	Medium	Low	Low
Fertilizer supply	Medium	Low	None	Low	Low
Pesticides supply	Low	Low	None	Low	Low
Machinery supply	Low	Low	Very low	Low	Low

Source: Analysis by the authors based on this study.

The majority of smallholders in remote rural areas of hills, mountains and Terai have limited access to NARC research. They neither have a say in the processes of research priority-setting and technology development nor access to new technologies once they have been developed by NARC.

The analysis of overall effects of industry structure on the ability of smallholders to access new technologies revealed that most of the desirable technologies are not readily available. Of these, new seed varieties and other agriculture-related technologies are more appropriate for smallholders (Table 3.3).

TABLE 3.3.THE EFFECT OF INDUSTRY STRUCTURE ON THE ABILITY OF SMALL-SCALE RESOURCE-POOR FARMERS TO ACCESS NEW TECHNOLOGIES

New technologies	Accessibility to smallholders			
	Existence of new technologies in Nepal (Yes/No)	Appropriateness (High/Medium/Low)	Availability (High/Medium/Low)	Affordability (High/Medium/Low)
Seeds of new varieties	Yes	Medium	Medium	Medium to High
Fertilizers/nutrient management technologies	Yes	High	Low	Medium
Pesticides/IPM	Yes	Low	Low	Low to Medium
New machinery or equipment	Yes	Low	Low	Low

Source: Analysis by the authors based on this study.
Note: IPM =integrated pest management.

Policy options to improve technology access

Policy options

If anything is dynamic in Nepal, it is the policy environment. Policies keep changing before being fully implemented. Currently, preparations are underway to revise or replace the following policy instruments:

Agriculture Perspective Plan (APP)

The major policy framework for agriculture growth in Nepal is undergoing a revision to develop an Agricultural Development Strategy (ADS). Major gaps were identified in the implementation of the APP, e.g. poor coordination between government line-departments resulting in weak implementation,

a lack of financial resources, and a lack of needed institutional reforms. All of these gaps would need to be addressed by the new strategy.

New fertilizer policy of Nepal

The fertilizer policy is also undergoing change. A new fertilizer policy must first address the need to supply Nepal's full fertilizer requirements (a demand for 580,000 tons per year), and those figures do not even consider additional fertilizer needed for increased crop intensification and increased commercialization of agriculture.

One strategy is to try to strengthen existing agricultural production systems by building on and improving existing on-farm practices for soil fertility management using the concept of Integrated Plant Nutrient Management (IPNM) that integrates all available means of soil, nutrient, and crop management to achieve optimum productivity. These include organic, mineral fertilizers, and biological sources of plant nutrients and better crop husbandry (Subedi and Weber 2001). This is particularly needed for the hills and mountains where it is more difficult to deliver fertilizers. However, both IPNM and targeted fertilizer-dosage involves a quite complex extension message, and would need to have an efficient extension system to disseminate it.

A second strategy to address issues related to fertilizers is to be more context-specific and account for the high agroecological diversity in Nepal—this is an approach that current policy does not cover. Soil-nutrient status across agroecological domains needs to be determined to identify and quantify nutrient-deficiency problems. There has been no such study since the mid-1980s, but it would allow recommendations for economical fertilizer doses for various cropping patterns across agroecological regions. There are vast differences across Nepal in production potential, access to inputs, markets, and technologies so a future policy on fertilizer should not have a blanket recommendation. Separate policy options are needed for accessible versus inaccessible areas and high-potential production systems with high cropping intensities versus marginal agriculture. Although this would help increase the efficiency with which fertilizers are used, it does not solve the problem of inadequate supply.

A third strategy is to invest in manufacturing phosphatic fertilizers over the medium-term horizon (three–five years) in areas such as Baitadi and Bajhang where considerable phosphorite deposits have been identified. Laboratory analysis indicated 15–32 percent P_2O_5 in the ore (Pradhanag 1986).

A fourth strategy is to initiate bilateral talks between the Governments of India and Nepal to include fertilizer as a commonly traded commodity. As a short-term option, which could then be linked with a bilateral agreement, the Nepal government could encourage farmers to bring quality fertilizers from India to meet their needs. It could also explore the possibility of small traders, Agrovets, and private companies bringing fertilizers using a variety of means for use in the Terai and other accessible areas in the hills. Given the lack of fertilizers supplied on time and in adequate quantities through government parastatals, an informal flow of fertilizers from India (which are also cheaper due to substantial government subsidies) fills the gap. Good quality fertilizers so imported would always contribute to improve the crop productivity of Nepal. Nepal's fertilizer market is merely one percent to that of India (Thapa 2006) and even if fertilizer is made a commonly traded commodity, it would hardly have any adverse impact on the overall fertilizer situation in India.

A fifth strategy is based on extending government subsidies to cover sufficient fertilizer to meet needs. This involves a broader policy consideration by the Nepal government. For example, what should be the overall policy regime on government subsidies? What priority should be assigned to subsidies on petroleum products versus fertilizer (and diesel) for agricultural operations? Currently, such policy guidelines are only evidenced by the subsidies in place.

If fertilizer subsidies are extended, then the existing problems of delivery have to be avoided. Currently, the National Fertilizer Company Limited (NFCL) is the sole agency for handling subsidized fertilizers, which is sold through the network of cooperatives (owned by the government) and fair-price cooperatives. This system is highly criticized as fertilizers are never imported and delivered on time and there is inefficiency and financial misappropriation. The private sector could be encouraged to procure and sell subsidized fertilizers, although they would have to be assured of having equal terms

to that of NFCL. There may be a need for an initial investment in this sector as a joint venture (public-private partnership) if fertilizer is imported in large consignments from the international market and not just India. Alternatively, many Agrovets already deal in fertilizer and are capable of expanding sales if they can officially import it from India.

Another way of delivering subsidized fertilizer on a pro-poor basis is the introduction of a targeted voucher system for distributing fertilizers (Denning et al. 2009). However, such a system is not without difficulties such as high administrative costs, and the reselling of vouchers by the target group. Also, the voucher system was designed to encourage private input-dealers in Malawi and there is less need to do this in Nepal. Nonetheless, if a voucher system were to be used in Nepal, the vouchers would have to be redeemable in both the private sector and government outlets.

Improvement in seed regulatory frameworks

Encouraging private investment in plant breeding and the seed trade would contribute to food security and poverty reduction by increasing the availability and choice of better technologies for smallholders. However, amendments to the variety release process are needed to encourage substantial private sector investment on plant breeding:

- An independent authority should generate data on distinctness, uniformity, and stability (DUS). Currently this is done by the Nepal Agricultural Research Council (NARC), which is also the major crop-breeding and variety-releasing institution in Nepal. Hence, there is a conflict of interest
- Representation of stakeholders from outside of NARC on the Variety Approval, Release, and Registration Committee (VARRC) should be increased. Currently, the committee is comprised of a majority of NARC scientists, and again there is a conflict of interest
- The provision of “truthfully labeled” seeds should be popularized to help in the deregulation of the market and to give greater flexibility to the private sector
- A strong quality-monitoring mechanism should be put in place to discourage the sale of spurious seeds falsely packaged with the branding of reputable companies.

The slow pace of introducing new varieties delays their benefits for smallholders: policies are needed to encourage seed production of new varieties. A modest subsidy on new varieties, as applied in India, would help. The government often approves bilateral projects that involve the distribution of agricultural inputs such as the European Union–funded and FAO-managed Food Facility project, and the World Bank–funded Nepal Food Crisis Response Programme. They should insist that in such projects, priority is given to newer varieties adapted to specific ecological conditions. It would raise awareness of the importance of varieties and avoid mistakes that have been made in distributing seed of varieties un-adapted to the local environment. Since most varieties officially released by NRRP have had limited testing with farmers, feedback from farmers should be solicited for the initial seed distribution of the newest varieties.

Policy on agricultural mechanization

Agricultural mechanization can contribute to the growth of agricultural production and rural development while reducing rural poverty. Correct and timely government interventions are crucial to achieve these kinds of objectives. For example, the development of minor irrigation—particularly private, investment-based expansion of shallow tube wells—contributed to the impressive performance and expansion of boro rice in Bangladesh. This was an outcome of the government’s market liberalization policy for irrigation equipment in the late 1980s. This policy promoted rapid expansion of irrigated boro-rice farming in the dry season (Hossain 2009). Similar interventions are needed in agricultural mechanization in Nepal. In the same vein, linking rural and agricultural mechanization with occupa-

tional castes of Nepal, particularly liberated Haliyas[11], Kami[12] and Luhar for manufacturing, importing, and marketing agricultural tools and equipment can contribute to poverty reduction in rural areas. This can be done by setting up cooperatives to increase employment opportunities, improve livelihoods, and reduce poverty.

In the Terai, large businesses are dealing with agricultural machinery; there is little need to change policy to encourage these enterprises. However, these businesses do not operate in the low- and mid-hills and an alternative outlet is needed such as cooperatives. These could be linked to the businesses in the Terai by, for example, operating on a commission basis or by linkages for spare parts, repairs, and maintenance. Although the cooperative movement in Nepal is not without its problems, there are success stories as well. To encourage their establishment, the policy should be to promote training in business development services (BDS) and marketing skills, using experts from successful businesses or professionals from universities. Concentrating on selling agricultural machinery may be too restrictive and cooperatives would need to deal with other products.

Revisiting public investment priorities and strengthening implementation:

Analysis of return on public investment in various sectors may be needed for refining overall government investment plans. However, research by IFPRI has indicated that public investment on infrastructure such as rural roads, and in agriculture research and development (R&D) and education, can significantly reduce poverty. Increasing share of funding to impoverished and previously un-served regions can be truly a pro-poor public investment, generating income in rural areas by creating positive impacts on agricultural profitability, agricultural wages, rural non-farm employment, and overall poverty reduction (Renkow 2010).

The importance of agricultural R&D for the nation's development has been highlighted in a number of important policy documents, but instability at the ministerial level and a lack of political will power continue to pose a major challenge; witness the failure of implementing policies, programs, and activities. The country needs to put effective and efficient policy implementation bodies and instruments for agricultural R&D in place if it is to succeed in enhancing smallholder production, cutting rural poverty, and competing in a global market (Rahija et al. 2011).

[11] Traditionally, bonded plowmen from the Dalit families responsible for all of the plowing in the hills for so- called upper-caste people. All such families have been liberated by a government order without proper arrangement for their settlement and livelihood security.

[12] *Kami* and *Luhar* are occupational castes mainly responsible for making agricultural tools and equipment.

POLICY FRAMEWORKS

Strategies of Government of Nepal for agricultural growth and poverty reduction

Nepal's development plans have had agriculture as a central component, and there has been a continuing evolution in agricultural plans that have all been committed to growth, development, and poverty reduction (Table 3.1). That said, there has been a lack of clarity in the formulation of policy. As a result, the agricultural plans overlap in their time frame and have the same overarching goals, while differing somewhat in their emphasis.

- The Agriculture Perspective Plan (APP) emphasized infrastructure and technical issues i.e. the provision of irrigation, roads, fertilizer, and technology development, as well as the development of agribusinesses
- The National Agricultural Policy (NAP) placed emphasis on the commercialization of agriculture with the encouragement of the private sector and cooperatives, and added the concept of sustainability through the conservation of natural resources and biodiversity
- The Three-Year Interim Plan (TYIP) had the APP as its principal policy instrument, integrating the APP with the NAP and adding the concept of market chains and networks for commercialization

TABLE 4.1—POLICY DOCUMENTS RELATED TO AGRICULTURAL GROWTH AND FOOD SECURITY IN NEPAL

Policy	Year or period enacted	Source
Seed Act	1988	NSB, MOAC
Agriculture Perspective Plan (APP)	1997–2017	APROSC/JMA, 1995
National Seed Policy	1999	NSB, MOAC
Millennium Development Goals (MDG)	2000	UNDP
National Agriculture Policy (NAP)	2004	MOAC
Tenth Plan and Poverty Reduction Strategy Paper (PRSP)	2003	NPC
Interim Constitution of Nepal	2007	NPC
Three-Year Interim Plan (TYIP)	2007–08 to 2009–10	NPC
Plant Variety and Farmers' Rights Protection Bill (draft)	-	NSB, MOAC

Sources: As indicated.
Notes: NSB = National Seed Board; MOAC = Ministry of Agriculture and Cooperation; APROSC/JMA = Agricultural Projects Services Centre–John Mellor Associates; UNDP = United Nations Development Programme; NPC = National Planning Commission of Nepal.

We deal below in chronological order with policies relating to agriculture in general and then with policies relating particularly to seed.

Seed Act, 1988

The 1988 Seed Act regulates Nepal's seed regime and was enacted with a view to promoting the provision of high-quality seed to increase crop yields. Initially, the act was enforced just in Kathmandu, Bhaktapur, and Lalitpur districts (Nepal *Rajpatra* meaning Nepal Gazette) 1989) but is now enforced in 33 districts of Nepal: all 20 Terai, 11 out of 39 mid hills and 2 out of 16 high hills (Nepal, Ministry of Agriculture and Cooperatives 2008). In the rest of the districts, the Act is yet to be implemented, although several of those districts are equally important in terms of agricultural production and seed trade.

The major provisions of the Act relate to the functioning of a National Seed Board, a Seed Certification Agency, and a Central Seed Testing Laboratory to control germination and purity standards. It established a Seed Inspector and penalties for contravention of the Act.

The National Seed Board is the major institution authorized to formulate the necessary policies on seed, and to coordinate the private and public sector regarding seed production and distribution. It is

authorized to approve, release, and register new varieties of crops according to prescribed rules. There are also provisions regarding the right of ownership that relate to the varieties registered by private-sector companies.

The functions, duties, and powers of the Seed Certification Committee provide for a breeder to register and release a new variety that meets the criteria of distinctiveness, uniformity, and stability (DUS). The rules complement the International Union for the Protection of New Varieties of Plants (UPOV) and hence provide right of ownership to the breeder. The act has also adopted similar standards as those of UPOV for the assessment or examination of new varieties.

Although the Seed Act 1988 was not fully functional, it certainly contributed positively, particularly with respect to variety release and the registration process. The increase in the number of variety release after 1988 by 120 percent can also be attributed to the formation of the Nepal Agricultural Research Council (NARC) as an autonomous institution. Seed quality management, particularly through regional laboratories, also improved after the Act. However, seed quality monitoring and enforcing penalties for contravention of the Act have yet to be improved.

Agriculture Perspective Plan (APP)

In 1997, what was then His Majesty's Government of Nepal (HMGN) adopted a 20-year Agriculture Perspective Plan (1997–2017) with the aim of accelerating agricultural growth from about 3 percent in the first half of the 1990s to 5 percent in the following 20 years. The APP was the principal policy instrument for achieving the food and agricultural sector goal of the Ninth Plan; as its main aim, the Plan sought to reduce the incidence of poverty from 42 percent in 1997 to 32 percent in 2002 by accelerating the rate of economic growth to 6 percent. The APP and the Ninth Plan (1997–2002), supported by macroeconomic reforms, aimed to achieve sustained economic growth through a transition to a more market-oriented and increasingly private-sector-based economy.

The APP's priority areas were lowering food prices, generating livelihood opportunities in agriculture and the rural non-farm economy, reducing poverty, and improving food security. Priority areas for investment emphasized by APP were: shallow tube-well irrigation in the Terai; agricultural roads, such as those to provide farmers with access to markets; fertilizer; and technology development and delivery (research and extension).

The priority commodities identified by APP were rice, citrus, apple, vegetables, livestock, and forestry products. Agribusiness was emphasized as part of a commercialization strategy.

Major policy prescriptions include emphasis on the production and availability of nutritious foods at the household level, as well as reduced malnutrition. It also recognized the vital, but widely unacknowledged, role that women play in economic life. In so doing, it aimed at integrating women into the development mainstream to help empower them, and attain the goal of gender equity.

The adoption and implementation of the APP has fallen far short of targets, even though those of the Millennium Development Goals were largely met (see below). Coordination has been poor (and has recently worsened), investment has been far short of targets, and many of the important institutional reforms demanded by the plan are still only under consideration (IDL 2006; NARMA 2006; Thapa 2006). Since all the other plans relating to agriculture lie within the timeframe of the APP, they have also fallen short of their targets and suffered from the same deficiencies.

National Seed Policy, 1999

The 1999 National Seed Policy has many statements to strengthen the private seed sector (Nepal Rajpatra 2009). The policy allows all sectors to develop crop varieties, multiply different classes of seeds, and be involved in the seed trade. It envisages increasing the capacity of the private sector by government support for training and facilities, tax exemptions, and other regulatory support. It emphasized three main activities:

- Strengthening the private sector in activities related to producing and selling seeds in remote areas

- Establishing farmers' groups to conduct seed activities in these areas
- Making seed production technology available particularly to private-sector agencies involved in seed production, and providing a subsidy for the transport of source seeds from seed source centers to farmers' fields

There has been a shift in policy. On June 21, 2005, the Ministry of Agriculture and Cooperatives (MOAC) issued a notice in the Nepal Gazette, Section 3**,** with major modifications to the requirements for crop variety release, and additional sections to the "National Listing" for any crop variety. For the release proposals, it recognizes data generated using participatory varietal selection (PVS) trials—typically Mother and Baby trials. It also requires multi-stakeholders' preference criteria to make the release process more client-oriented and participatory. For registration or national listing, only one year's field data are required on agronomic performance, and only a limited amount of information is demanded on morphological, economic, and processing characteristics. This big policy shift includes underused crops and landraces of any crop that can be listed in the national register and have their custodians identified. This places them in the national research and development system, and has significance for biodiversity conservation.

With regard to biotechnology, the seed policy has the following provisions:

- Specific studies and research on genetically modified organisms (GMOs) and transgenic plants to understand their potential in Nepal (Policy No 3.7.1)
- The imported seeds and plantlets containing spliced genes from other countries shall be studied under the supervision of a related government authority and if the products are certified to have no negative effect on organisms and the environment, then only shall these be promoted for public consumption (Policy No. 3.7.2.)
- The policy also states that biosafety rules and regulations suited to the Nepalese context shall:
    - Be prepared and implemented for the benefit of the general public (Policy No. 3.7.2.)
    - Be formulated to plan for developing human sources and physical facilities for the development and use of modern technologies (Policy No. 3.7.4)

Despite the flexible provision of National Seed Policy 1999, the National Seed Board and its members, and the Variety Approval, Release, and Registration Committee (VAARC) are less flexible in practice regarding variety approval and release. Many times they use similar criteria both for release and registration of varieties. Even the flexibility of proposing a popular name to a registered variety is not left to the proposers of a variety for registration.

Millennium Development Goals (MDGs), 2000–2015

Nepal endorsed the Millennium Declaration in September 2000 with a commitment to work toward achieving the MDGs by 2015. The MDGs set quantitative poverty reduction targets and specific goals in health, education, gender equality, the environment, and other aspects of human development, measured in terms of outcome and impact indicators.

Government reports indicate that Nepal will achieve most of its MDG targets (that were set in 2000) by 2015 with a few major exceptions such as providing full employment and eradicating extreme poverty and hunger (MDG1), and ensuring environmental sustainability (MDG7) (Nepal, National Planning Commission 2010c). Poverty fell by more than five percentage points from 2005 to 2010. Both chronic and transitory food security situations have improved. However, production of major cereal crops except wheat is declining and, as described in the background above, chronic hunger is still persistent. The policies to achieve MDG1 relating to agriculture were formulated in the National Agricultural Policy (NAP) and the Three-Year Plan (TYP) discussed below (Nepal, National Planning Commission 2010b). However, others indicate that major driver for poverty reduction was remittances from Nepalese working overseas rather than the effect of national policy instruments.

National Agricultural Policy (NAP), 2004

The NAP, as with all of the agricultural plans including the APP, shared the common goal of increasing agricultural productivity. Compared with the APP it placed more emphasis on commercialization. It sought "to strengthen and develop competitive and commercial agricultural systems that can compete in regional and world markets" and "to conserve natural resources, biodiversity and environment for the long-term sustainability of the production systems."

There are many reasons for lack of commercialization and competitiveness during the previous plan period. These include small size of holding and lack of infrastructure such as irrigation, transportation, and communication. Lack of modern technologies and innovations related to production, processing, value added, and marketing were other reasons. Sustainable agriculture development was to be achieved by transforming the existing subsistence-oriented farming system into a commercial and competitive farming system. The policy emphasized production, use, and promotion of organic fertilizers. Biodiversity conservation, promotion, and use were also envisioned in the policy (Nepal National Planning Commission 2010b).

To develop commercial and competitive farming systems, the NAP proposed various measures to exploit the comparative advantage of Nepal's specific physiographic and agro-climatic conditions. Private-sector cooperatives and other entrepreneurs were to be greatly encouraged to be involved in agricultural research, development, and training. The policy strongly advocated organizing farmers and entrepreneurs into cooperatives by mobilizing local capital and other resources. Such cooperatives in rural areas would develop as local delivery hubs to provide production inputs and services to farmers and facilitate their access to markets.

Production and use of hybrid varieties of crops and other improved breeds were also encouraged and the use of genetically modified organisms (GMOs) regulated in accordance with the National Seed Policy of 1999 (see also 2.1.3. above). In the 2004 NAP, agricultural research and development were opened to private and foreign investment. It emphasized improving rural infrastructures and facilities needed for agriculture growth, including the supply of inputs e.g. fertilizers and seeds.

The NAP was formulated with the following provisions:

- It encourages cooperatives and the private sector to establish and manage community and private agricultural research centers
- Simultaneously, government farms will be strengthened to facilitate the supply of agricultural inputs, provide technical support to communities and private resource centers, and make the quality of such inputs trustworthy
- Special concessions and facilities will be provided to farmers below the poverty line, who will be organized into groups to manage and use improved farmyard manure, compost, and cattle urine
- It encourages rainfed agricultural technologies in unirrigated marginal areas to improve crop productivity
- It emphasizes developing and using small and appropriate agricultural tools that reduce women's workload women, improve labor productivity, and add labor value. The policy also mentions the need to develop and disseminate processing, packaging, food biotechnology, and storage technologies to stakeholders

The NAP is considered a broad-based plan to promote economic growth through the modernization and commercialization of agriculture. It encourages the involvement of the private sector and cooperatives and adds the concept of sustainability through the conservation of natural resources and biodiversity. To some extent, the NAP was also politically motivated as it was developed during the direct rule of King Gyanendra to reduce the impacts of the insurgency.

The NAP was not very suitable for smallholders, however, because it focused on accessible and high-potential production systems whereas the majority of smallholders live in rural and marginal areas.

Tenth Plan and Poverty Reduction Strategy Paper (PRSP), 2003–07

The government prepared the Tenth Plan as a Poverty Reduction Strategy Paper (PRSP). The original goal of PRSP was to reduce poverty from 38 percent to 30 percent in 2006–07. It sought to bring the rural population into the development mainstream with priority on agriculture and other sectors that have strong, growth-promoting, forward and backward linkages. The plan also sought to reduce economic disparities between regions and communities and to decentralize implementation of development programs and projects. The plan identified the need to develop a policy environment conducive to private-sector participation and to implement the necessary institutional reforms. According to Nepal's Ministry of Finance (2010), poverty fell significantly during the Tenth Plan period, but other studies disagree with these figures. For example, a University of Oxford study indicated that 67 percent of people in Nepal were living with multidimensional poverty in 2009.

The Three-Year Interim Plan (TYIP)

The 2007 Interim Constitution of Nepal established the fundamental right to food. The Three-Year Interim Plan (TYIP) accepted food production, availability, access, and stability as interrelated dimensions of food sovereignty. Food and nutritional security in Nepal thus clearly received attention in national policies and strategies.

The TYIP's overall goal was to achieve broad-based, gender-inclusive, and sustainable agricultural growth by modernizing and commercializing the agriculture sector. It would accomplish this by integrating the APP and the National Agricultural Policy 2005 as the central policy for developing and strengthening competitive agriculture. To that end, it would seek to understand value and market chains and use market networks to maximize benefits from agriculture products. The TYIP also envisaged reaping benefits from international trading organizations such as the World Trade Organization and the South Asian Free Trade Area.

Given the severe food insecurity of people below the poverty line, including those in disadvantaged groups, as a result of slow and low adoption of modern and sustainable management practices, the APP and the TYIP prioritized the development of agriculture in the country. To achieve the targets set by these plans, new yield-enhancing technologies had to be developed and adopted, as there was little scope for expanding the area under cultivation.

The TYIP identified social programs to free people from poverty who were unable to get mainstreamed into the development process for sociocultural, geographical, and economic reasons. These programs gave priority to women, *Dalits*, ethnic minorities, *Madheshi* people, small farmers, the ultra-poor and people living in remote areas.

The TYIP aimed to make agriculture and livestock services demand-driven, inclusive, and results-oriented. To achieve this, the plan encouraged the development, packaging, and dissemination of modern technologies and innovations to reduce the cost of agriculture and livestock products. The TYIP aimed for a growth rate of 3.6 percent to help reduce unemployment, poverty, and inequality. Priority sectors for investment were infrastructure such as electricity, roads, and irrigation, as well as communications that supported reconstruction and rehabilitation. Similarly, the plan aimed to invest more in health, education, drinking water, and sanitation.

The TYIP was basically a politically motivated policy document to address the aspirations of people after the popular movement of 2006 that ended monarchy in Nepal. Therefore, it is not surprising it had comprehensive lists of targets and needed changes but lacked plans on how to implement them.

Plant Variety and Farmers' Rights Protection Bill (Draft)

This draft act contains broad provisions regarding farmers' and breeders' rights. Plant breeders' rights are protected to an extent compatible with standard international norms and rules; breeders enjoy monopoly rights for their new variety for 25 years.

The bill was drawn up primarily to meet the requirements of plant variety protection by establishing *sui generis* laws for this purpose under the Trade-Related Aspects of International Property Rights (TRIPS) agreement. It is now unlikely to be enacted in the near future because the concerned authorities have not taken it seriously to complete the task well in time as a result the deadline for least-developed countries to comply with the TRIPS agreement has been extended to July 2013.

Policy/regulatory frameworks on biodiversity, its management, and use

Nepal's location in the center of the Himalayan range places the country in the transitional zone between the eastern and western Himalayas. Nepal's rich biodiversity is a reflection of this unique geography, as well as its altitudinal and climatic variation. Although comprising only 0.09 percent of global land area, Nepal possesses a disproportionately large diversity of flora and fauna at genetic, species, and ecosystem levels. Biological diversity in Nepal is closely linked to the livelihoods and economic development of most of its people and relates to agricultural productivity and sustainability, human health and nutrition, indigenous knowledge, gender equality, building materials, water resources, and the aesthetic and cultural well-being of society (Nepal, Ministry of Forest and Soil Conservation 2002).

The Nepal Biodiversity Strategy (NBS) serves as a guide to all government organizations, the private sector, and civil society. It set out the objectives for the protection of biological diversity in Nepal, and identified or restated government policy on natural resources and their diversity. It sought to provide a strategic planning framework for the conservation of biological diversity, the maintenance of ecological processes and systems, and the equitable sharing of accrued benefits. The NBS integrates the conservation and sustainable use of diversity of biological resources with national development processes (Nepal, Ministry of Forests and Soil Conservation 2002). The Ministry of Forest and Soil Conservation serves as the national focal point for the Convention on Biological Diversity.

The major policies and legal framework related to biodiversity conservation are the following:

- Forest Act 1993 and Regulation 1995
- Environment Protection Act and Regulation 1997
- National Biodiversity Strategy 2002
- National Wetland Policy 2003
- Working Policy on Wildlife Farming, Breeding and Research 2003
- Agriculture Policy 2004
- Nepal Biodiversity Strategy Implementation Plan 2006
- Biotechnology Policy 2006
- National Biosafety Framework, including Biosafety Policy 2007

The NBS seeks to consolidate and build on past successful efforts and prescribes additional interventions to address the root causes of the major threats to Nepal's biodiversity as outlined below (Nepal, Ministry of Forest and Soil Conservation 2002):

- Low levels of public awareness and participation
- High population pressures and prevailing poverty
- Weak institutional, administrative, planning, and management capacity
- Lack of integrated land- and water-use planning
- Inadequate data and information management
- Inadequate policies and strategies for biodiversity conservation

Since human and financial resources are limited, criteria are proposed for ranking problems and root causes identified according to their overall impact on biodiversity and priority for remediation.

The NBS Implementation Plan envisioned teams responsible for specific projects, as well as the creation of a body: the National Biodiversity Unit as a secretariat of the National Biodiversity Co-ordination Committee (NBCC).

National Agrobiodiversity Strategy

In an agro-based country like Nepal, where agrobiodiversity is the backbone of the sustainable development of agriculture, food security, and poverty alleviation, it is the national responsibility to conserve, maintain, and make sustainable use of the available diversity. This necessitates effective institutional environment and programs to meet the needs and aspirations of future generations.

Realizing the significance of agrobiodiversity and the national commitment to the Convention on Biological Diversity (CBD) 1992 and recognizing also that the International Treaty on Plant Genetic Resources for Food and Agriculture (PGRFA) came into force on June 29, 2004, and other international treaties and agreements, the National Agrobiodiversity Strategy was formulated with the vision of conserving and making sustainable use of agriculture genetic resources and associated traditional knowledge with the participation of concerned stakeholders for present and future generations. The strategy intends to recognize agrobiodiversity as an integral component of biodiversity based on the spirit of international treaties/agreements and national initiatives to ensure social, economic, and environmental benefits to the Nepalese people (Nepal, Ministry of Forests and Soil Conservation 2002).

Objectives

- To enhance agriculture growth and ensure food security by conserving, promoting, and sustainably using agrobiodiversity
- To protect and promote the right and welfare of the farming communities for their indigenous knowledge, skills, and techniques
- To develop options for a fair and equitable sharing of benefits arising from the access and use of agriculture genetic resources and materials
- To create effective management, commercialization, and use of agricultural genetic resources in the present context of exploiting local national and international markets and in international regulations on trade
- To contribute to maintaining sustainable ecological balances (ecosystem services) over time
- To promote the conservation and use of agrobiodiversity in the context of national seed, food quality and safety, and product marketing regulations
- To promote inter-ministerial, inter-sectoral consultation, problem identification, and regulation-development as far as agrobiodiversity is concerned

The policy has provision for both *in situ* and *ex situ* conservation of agrobiodiversity. These approaches would be supported by scientific activities such as regular exploration, collection, evaluation, and monitoring. The status of genetic resources will be prepared and the inventory of such resources updated through scientific studies, biotechnological tools, and analysis of market and non-market economic values of different agrobiodiversity.

The policy gives priority to the use of agrobiodiversity for generating and disseminating technologies to benefit farming communities. A focal point designated by the government will coordinate and exchange information with concerned stakeholders. Another priority area is human resource development on agrobiodiversity. The policy clearly outlines mutually agreed terms to share benefits by developing national legislation and regulations, including a *sui generis* system.

The following are included in the policy:

- Provision for economic and financial incentives for the participation of communities
- Encouragement to government organizations, private sector, NGOs/INGOs for implementing agrobiodiversity related projects
- Adoption of a transparent and effective financial management and monitoring system
- Development of necessary sectoral policies, legislations, and regulations for effective implementation

Biosafety in relation to agriculture growth and poverty reduction

The current policy regime in relation to biosafety

While formulating biosafety policy the concerned government department reviewed and analyzed the documents, acts, and regulations listed below to harmonize other policies with biosafety policy. However, this review mainly draws from the biosafety policy:

- Food Act, 1966
- Feed Act, 1966
- Millennium Development Goals (MDGs) document 2000
- The Tenth Plan 2002–2007
- Nepal Biodiversity Strategy, 2002
- National Wetland Policy, 2004
- Sustainable Development Agenda 2003
- Science and Technology Policy, 2004
- Biotechnology Policy, 2006
- Consumer Protection Act, 1997
- The Export Import (Control) Act, 1956
- Plant Protection Act, 1972
- Seed Act, 1988
- Animal Health and Livestock Services Act, 1998
- Slaughter House and Meat Inspection Act, 1999
- National Dairy Development Act, 1991
- Nepal Agricultural Research Council (NARC) Act, 1991
- Drug Act, 1978
- National Park and Wildlife Conservation Act, 1972
- Forests Act, 1999
- Aquatic Animal Protection Act, 1960
- Environment Protection Act, 1997
- The Patent Design and Trademark Act, 1965

To ensure a high level of biosafety in trans-boundary movement and use of genetically modified organisms (GMOs), the Government of Nepal aimed to develop a detailed national biosafety framework and implement it effectively. Nepal's biosafety policy, which is based on precautionary principles, emphasizes the use of transparency, prior informed agreement, and participatory approaches. Its main objective is to contribute to poverty alleviation through the development and application of biotechnology with comparative benefits.

Nepal is a party to the Convention on Biological Diversity and committed to biosafety by signing the Cartagena Protocol on Biosafety in March 2001. Its main objective was to pay special attention to the trans-boundary movement of GMOs produced through modern biotechnology, and regulate the import and export of such goods only on the basis of prior informed agreement. According to the provisions of this Act, Nepal has an international obligation to prepare policies and legislations on biosafety.

The Ministry of Forest and Soil Conservation (MFSC) is the national focal point for the Convention on Biological Diversity and the Cartagena Protocol. A National Biosafety Committee (NBC), under the chairpersonship of the secretary of MFSC with representation from different sectors has been envisioned. The committee would act as a National Competent Authority on any issues related to GMOs and adopt a transparent decision making process in relations to GMOs and related activities, including environmental risk assessment, social impact assessment, monitoring and enforcement, and provision of penalty and redress.

Technical Framework: A technical framework for biosafety is required to control any adverse effects on biological diversity and on human health, including the social and cultural values of the nation, from the use of permitted GMOs in the environment. For this, trained human resources, well-equipped laboratories, and operational procedures are required, along with the scientific examination of the risk of GMOs.

The following points were considered for the purpose of risk management:

- The GMOs in question should be subject to an adequate period of observation, at least through their lifecycle
- The package containing GMOs or their products need to have labeling with general information on GMOs or their products and potential allergies
- The application of the accepted risk management measures may include one or all of the following in combination:
    - Physical—separation of the area where GMOs will be used by dams, canals, boards, nets, and similar other physical barriers,
    - Chemical—sterilization of the used instruments, facilities, and media, alongside use of other chemical measures to ensure risk management, and
    - Biological—establishment of biological buffer areas.

Administrative framework: Administrative aspects of biosafety would include engaging ministries, departments, and government offices at the district level, and providing services of respective sectors. However, existing legislation has not designated any responsible institutions for research, development, testing, import, and release of GMOs into the market or the monitoring of such activities.

An administrative mechanism has to be established in order to perform biosafety-related activities on research, development, import, and export of GMOs and their products, and to inform stakeholders about these activities in a transparent way.

The government and NGOs have provisions for disseminating information through public awareness-raising programs, asking for public comments and participation in the decision making process by representatives of civil society in their respective field of works.

Information on the benefits and risks of GMOs and products thereof, as well as the measures to be taken to avoid or minimize the risks of such products, have to reach people in remote areas. This includes people with low literacy, as well as ethnic communities having their own dialects or languages.

Framework for Public Participation: For effective public participation on biosafety issues including production, import, trans-boundary movements, and testing of GMOs and products thereof, it is required to:

- Work with NGOs and private institutions to develop, disseminate, and implement biosafety-related programs at the grassroots level, including information flow and awareness-raising programs on biosafety using radio and other mass media
- Develop curriculum and education materials on biosafety for different grades
- Develop human resources for producing literature and flow of information on biosafety in local languages
- Establish a national biosafety clearing house for information flow at the national, regional, and international level

Fertilizer-related policies in Nepal

Background

Fertilizer is a vital input not only to increase production, but also to increase the benefits from other inputs such as irrigation and improved seeds. The Agriculture Perspective Plan (APP) of the Government of Nepal, which has been in effect since 1997, identified chemical fertilizers as an engine of agricultural growth (Shrestha 2010). The APP assumed fertilizer as a principal factor that would contribute 64–75 percent of accelerated agricultural growth and improve household food security in Nepal. Hence, the APP envisaged an increase in fertilizer use from 31 kg of nutrients per hectare in the base year (1997) to 131 kg of nutrients per hectare by 2017 (JMA/APROSC 1995).

Until 1997, the Agricultural Inputs Corporation (AIC)—a public sector corporation established by the government in 1966—enjoyed a monopoly in the fertilizer trade. This parastatal was given full responsibility and resources to procure and distribute agricultural inputs such as fertilizers, seeds, pesticides, agricultural tools, and machinery. Following the poor performance of AIC in terms of timely delivery of quality seeds, fertilizers, and other agricultural inputs, and due to pressure from farmers, the government decided to convert and split this parastatal into two public limited companies: one dealing with seeds—the National Seeds Company Limited (NSCL)—and another dealing with fertilizers and other agrochemicals—the Agricultural Inputs Company Limited (AICL).

Up until the liberalization of fertilizer supply in 1997, AIC controlled fertilizer import, sale prices, and distribution. The AIC had the primary responsibility for the type and quantity of fertilizers to be imported and distributed. Fertilizer was sold to farmers at a subsidized rate, and the subsidies paid to AIC annually represented a heavy burden on the Treasury (although not as heavy as other subsidies such as the one on diesel). Fertilizer supply during this period was often constrained by insufficient allocation of government funds for subsidy and limited access to foreign exchange.

Nepal has two sources of fertilizers: official imports from India or other countries, and the unrecorded supply channels that include informal import from India (Thapa 2006). India continues to subsidize its domestic fertilizer sector, creating strong incentives for illegal trade across the long open border. The price is based on the Indian selling (subsidized price) price to farmers but in addition there are collection costs to make bulk quantities and informal payments to official agencies en route to Nepal. The informal import of fertilizers is estimated to be about three times more than formal imports (Thapa 2006). Hence, as indicated in Table 3.2, the Agricultural Sector Performance Review (ASPR) estimated that nearly two-thirds of all fertilizers in Nepal were imported from India through non-official channels (ACI 2003). While Nepalese farmers benefit from access to informally imported and cheap Indian fertilizers, the lack of quality control and payments to officials are cause for concern.

Policy analysts indicate that if Nepal subsidizes fertilizers at par with India, Rs.3.1 billion would be needed annually, which is only affordable if money is no spent on other, less equitable, subsidies. On the other hand, the fertilizer price- differences between these two countries are such that Nepal will always face a market failure unless it harmonizes with overall Indian agricultural policies. The price of urea in India was US $85 below the international price (India, Ministry of Finance 2006), while the import price of fertilizers at the Birgunj entry point in Nepal was 195 percent higher than the Indian price in 2006. Thus it is not surprising that farmers pay private traders to illegally import fertilizers from India and was estimated to account for 66% of the fertilizer used (Thapa 2006). The difference in the price of urea was attributed to the subsidy in India during a time when the subsidy had been removed in Nepal. Fertilizer use in Nepal seems to be increasing at a high rate, and data from field surveys indicate higher rates than those from trade statistics (Table 4.2).

TABLE 4.2—SOME VITAL STATISTICS ON FERTILIZER OR NUTRIENT USE IN NEPAL

Indicator for fertilizer or nutrient use	Rate of use (kg per ha)	Source
Estimated use of fertilizers for 3.3 million hectares of land from the import of 528,000 t of fertilizer	160	Thapa 2006
Annual increase in the use of fertilizers	11.5	ANZDEC 2002
Quantity of nutrients used by households in 2001	58	ANZDEC 2002
Quantity of nutrients used by households	56	OPM 2010
Average quantity of NPK fertilizers used by households in high potential and rainfed farms		LI-BIRD, FORWARD, SUPPORT Foundation, CARIAD (unpublished data for baseline study 2008)
Rice	186	
Maize	177	
Wheat	199	

Sources: As indicated.

Fertilizer-policy regimes in Nepal

Governments have changed their policies many times to ensure adequate supply of fertilizers in the country. Recently, the government re-introduced a subsidy on chemical fertilizers.

Fertilizer policy intervention in Nepal can be divided into three phases:

Until 1973: Systematic efforts of importing and distribution of fertilizers started with the establishment of the Agriculture Input Corporation (AIC) under the former Ministry of Agriculture in 1966. Until 1972, the cost of fertilizer plus transportation determined the price; commercial fertilizers in the hills would be more expensive than that of the Terai for the obvious reason of transportation costs. Later, with the increase in price in international markets, the policy was slightly altered to adopt a uniform pricing system: hill farmers would get fertilizers below the actual cost, whereas farmers in the Terai region would pay more than the actual cost to offset the cost of transportation.

1973–74 to 1997: With the rise in the price of fertilizers in the international market, the government decided to introduce price and transport subsidies in selected high hills and mid- hill districts in 1973–74. This was intended to encourage the use of fertilizers by providing them at a relatively low price, and to discourage outflow of fertilizers from Nepal to India by keeping the price 15–20 percent higher than in India. AIC would get the difference between the actual cost and the selling price and this increased with the growing demand for fertilizer in the international market.The government was unable to meet the increased subsidy requirement. As a result, AIC was unable to import fertilizers sufficient to meet the demand (Shrestha 2010). The supply and distribution of fertilizers was erratic, and the subsidies tended to benefit richer rather than poorer farmers. This strategy failed to achieve the desired objectives of increased access of farmers to fertilizer.

Nepal started receiving fertilizers under grant aid from countries like Germany, Canada, Japan, and Finland in the late 1960s. Some countries stopped the supply after 1991–92, while others reduced the volume (Thapa 2006; ACI 2003; OPM 2003; Shrestha 2010).

1997–2008: In response to the earlier failed strategy, the government decided in 1997 to deregulate the fertilizer sector, which made a few changes in the way the fertilizers' supply business was handled.

Phasing out fertilizer subsidies: The subsidy for diammonium phosphate (DAP) and muriate of potash (MOP) was completely removed in 1997.The subsidy for urea was phased out and completely removed in 1999.

De-controlling wholesale and retail prices of fertilizer: The AIC monopoly was ended by 1999. The Ministry of Agriculture and Cooperatives (MOAC) formulated a policy to allow the private sector to import and sell fertilizers after the removal of subsidy (imported under open general licensing), giving equal treatment to the private sector and AICL in 1997. The government then promulgated the Fertilizer Control Order, 1999, as per the Essential Commodity Control Act (ECCA).

Fertilizer Control Order: This ensured quality of fertilizer supplied to the farmers by:

- Having a quality control mechanism during import at the retail level
- Allowing any legally registered private firm to enter into the fertilizer business
- Providing fertilizer inspectors for quality checks (Nepal, *Rajpatra* 1999)

National Fertilizer Policy 2002: This policy sought to create an infrastructure for enhancing fertilizer consumption and promoting an Integrated Plant Nutrient Management System (IPNMS) for the efficient and balanced use of fertilizers.

The main features of the policy were:

- Fertilizer use to include three types of fertilizers—organic, chemical, and microbial
- Promotion of IPNMS to maintain soil fertility through minimizing soil degradation and likely negative impact of chemical fertilizer on its own
- Equal treatment of government, private, and cooperative firms involved in the fertilizer business
- Elimination of price subsidy, but continuation of transport subsidy for selected districts of high hills and mid hills
- Provision of buffer stocks to respond to the acute shortage of fertilizer during the main cropping seasons
- Encouragement of domestic production of fertilizer and provision for investing in fertilizer industries of neighboring countries (Nepal, *Rajpatra* 2002)

Following the deregulation policy in 1997, the supply from formal sources (AICL and private importers) improved slightly, but only up to 1998–99. This was because of the provision of a partial subsidy in urea import before November 1999 and the relatively favorable price structure prevailing in the international market. However, fertilizer imports went down after 1999–2000 as neither AICL nor private importers could import large volumes owing to the high international market price. Another big problem in fertilizer trade in Nepal was competing with subsidized Indian fertilizers and other adulterated and substandard fertilizers that were easily available in the free markets of accessible areas (Shrestha 2010; Thapa 2006).

Official fertilizer sales in Nepal after liberalization grew annually by 6.5 percent. However, AICL distribution of fertilizer in this period declined largely due to the strong entry of the private sector in the import and distribution of fertilizers. Since liberalization, the share of private sector imports of fertilizer has grown steadily, increasing to more than 60 percent of official imports in 2001–02. Moreover, the private sector mostly imported urea and DAP, which grew at an annual rate of 48 and 60 percent, respectively (ANZDEC 2002). Still, there was no advantage in terms of price of the fertilizers even

after the entry of private sector; this may have been caused by the sudden rise in price of fertilizers after 1999.

Current Policy on Fertilizer Subsidy: Deregulation policy largely failed to improve the supply of fertilizer or control the quality of fertilizers used in the country. The main factors were the rise in international prices; the high Indian government subsidy for fertilizers provided to Indian farmers, the uncontrolled inflow of illegally traded cheaper fertilizers from India, and the inability of the government to match Indian subsidies.

MOAC reviewed the existing fertilizer policy in October 2008 and, a month later, proposed changes to the Council of Ministers that would support small and marginal farmers. The government approved the new policy and finally endorsed modalities for implementation in March 2009. Major criteria set by the government's latest decision on subsidizing chemical fertilizers are as follows:

- Fertilizers with transport subsidy to be provided to the hilly districts with the highest priority to those with acute food shortage
- High priority to be given to the Karnali Zone special food production program
- Priority supply to farmers having up to 4 hectares of land in the Terai and up to 0.75 hectares in the hills
- Fertilizers to be retailed through AICL field offices, cooperatives, and fair-price cooperative shops

Pesticide-related policy

DDT and pyrethrum were imported for the first time in 1950 from the United States exclusively to control malaria (Rana 2001; Koirala et al. 2009). In 1952, Paris Green, Gammaxene, and nicotine sulphate were imported from the United States, again for malaria control (World Wildlife Fund 1995). The impact of DDT for the control of the malaria vector was so remarkable that it encouraged the use of pesticides to control agricultural pests. This resulted in the rapid increase in the import of chlorinated hydrocarbons (now known as organochlorines) followed by other groups of pesticides for use in agriculture. Manandhar (2007) notes the following chronological order of different groups of pesticides introduced into Nepal: organochlorines (1950s), organophosphates (1960s), carbamates (1970s), and synthetic pyrethroids (1980s).

The Pesticide Registration and Management Division (PRMD) in the Ministry of Agriculture and Cooperatives (MOAC) is responsible for providing licenses for the import and distribution of pesticides to wholesalers and retailers in accordance with the Pesticide Act of 1991. In 1998, the government began promoting the concept of integrated pest management (IPM) with the implementation of Farmers' Field Schools on rice. Since then, the concept has been integrated into regular planning process and now extends to a number of vegetables and food crops (Nepal, Ministry of Agriculture and Cooperatives, 2010b).

To support commercial agricultural initiatives in the country, the government enacted the Plant Protection Act in 1991. It is implementing subsequent amendments but they are yet to be fully effective due to various constraints. These include a lack of awareness even among the responsible government organizations and among other stakeholders, i.e., farmers, the agencies involved in the trading of pesticides, and consumers at large.

Pesticide policy regimes in Nepal

The Nepalese Parliament passed the Pesticides Act in 1991 (Nepal, *Rajpatra* 1991). The cabinet approved the Pesticides Rules in July 1994.

The Pesticides Act 1991 has a provision for the import, export, production, marketing, and use of pesticides meant for killing harmful pests that appear in various seeds, trees, animals, and fowl. It also allows for a Pesticide Committee chaired by Secretary of the MOAC consisting of 15-members from

various government ministries, departments, distinguished scientists, pesticide entrepreneurs, users, farmers, and other members nominated by the Government of Nepal.

The function, duties, and authorities of the committee are:

- To advise the Government of Nepal on formulating national policy on pesticides
- To establish coordination between public and private sectors on import, production, and distribution of pesticide, and to encourage private sector investment in the pesticide industry
- To control the quality of pesticides produced by industry operated under both private and public sectors

The Act has a provision for a Pesticide Registration Office that would register appropriate pesticides and issue certificates after scrutinizing the applications submitted for the purpose of registering pesticides, and prepare necessary guidelines for effective, logical, and proper use of pesticides.

The Act allows for publishing the names of pesticides registered in Nepal in the *Rajpatra* the Government of Nepal on the recommendation of the committee. It can restrict the import, export, production, use, purchase, or sale of any other pesticide(s).

Payment of the prescribed fee is required to obtain a license from the committee for formulation, sales, and distribution. Similar processes are required to register the roster of the professional dealing with specific pesticides.

In 1994, to exercise authorities conferred by section 18 of Pesticide Act of Nepal 1991, the government approved the Pesticide Regulation 1994 (Nepal, *Rajpatra*1994). It details procedures related to various aspects of pesticides in Nepal, which are as follows:

- Application to be submitted for pesticide registration
- Registration of pesticides
- Denial of registration of the pesticide
- Cancellation or suspension of registration of pesticide(s)
- Furnishing particulars of pesticide import
- Approval of container and label
- Restriction for selling and distribution
- Obtaining license
- Submitting an application for the license
- Granting a license to pesticide retailer
- Granting a license to pesticide-spraying entrepreneur
- Granting a license to pesticide formulator
- Validity period of license and its renewal
- Revoking the license
- Providing an identity card to pesticide inspector
- Functions, duties, and authorities of the pesticide inspector
- Function, duties, and authorities and procedures of the meeting or the sub-committee

- Preparing and implementing the directives

Other policies related to pesticides in Nepal

The Environment Protection Act 1997 was introduced to maintain a clean and healthy environment. It takes into consideration sustainable development by recognizing the inextricable links between economic development and environment protection (Nepal, *Rajpatra* 1997). The Act focuses on the prevention and control of pollution to avoid causing any significant adverse impacts on the environment or those likely to be hazardous to public life and people's health.

The Environment Protection Rules 1997, enforced as of June 1997, were first amended in April 1999 (Nepal, *Rajpatra* 1997, 1999). The Rules have provision for an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) to be made as per Schedule 1 and Schedule 2.

The rules require an EIA for the agricultural sector and, in particular, the following activities relating to toxic substances (only those which are listed):

- Importing more than 10 tons of a toxic substance
- Sale, supply, storage, and disposal of more than 1 ton of a toxic substance
- Use of more than 1 ton of a toxic substance in a single area
- Activities relating to insecticide plants (factory) or toxic substances

With regard to the manufacture of pesticides, the Rules prohibit emitting waste from an industrial establishment in contravention of the prescribed standards of the Ministry (Nepal, Rajpatra, 1999)

Policies related to rural and agricultural machinery

The reality of rural areas

Because of existing laws, strong traditions and culture, land resources are generally inherited equally by all the sons in a family or next to kin from one generation to the next. This practice has resulted in continuous land fragmentation rendering the size of most holdings less economical; nearly 75 percent of famers have less than 1 hectare of land. This reality, coupled with risky and uncertain rainfed-farming, adds complexity to investment in the mechanization and commercialization of agriculture. In spite of these adversities, most people are still engaged in agriculture because they lack alternative employment opportunities. Lack of infrastructure and market opportunities further limits the scope for increasing investment in agriculture; as a result, the pace of mechanization and commercialization is slow.

Another major obstacle to mechanization in Nepal is the lack of electricity. Currently, urban Nepal (rural areas are deprived of electric power anyway) runs without electricity for nearly 16 hours a day; the vast majority of rural areas in the hills, mountains, and Terai have no electricity infrastructure at all. This has major implications for agricultural mechanization, implying that use of manual- and animal-drawn implements will continue in rural Nepal for some time to come.

Increasing returns per unit area of land depend on the combined use of improved technologies such as new high-yielding crop varieties, fertilizers, irrigation, crop protection, and modern machines for cultivation and agro-processing. Power-operated or appropriate animal-drawn agricultural machines contribute to the improvement in crop yields by speeding up farm operations, reducing the cost of crop production (by minimizing farm labor), and increasing land-use intensities and overall productivity.

They also have far-reaching consequences since time of family members saved by mechanization can be usefully used in other potential opportunities to improve income and family welfare. Well-designed agricultural mechanization can also contribute to creating more employment opportunities, as well as rural–urban linkages. Mechanization can also bring about changes in gender roles in productive activities and production relations, including the mobility of male and female family members.

In this context, mechanization is gaining importance even for smallholder farmers, particularly to achieve timeliness of farm operations and to manage the demand for farm power. Increasingly, it is becoming difficult to maintain farm animals, particularly for smallholders; this leaves no option but to depend on machines for farming. There is much evidence to suggest that resources are used more efficiently in small holdings than in large holdings (Stephen Biggs, pers. comm.).

There is a lack of a clear-cut policy on agricultural mechanization in Nepal and, as a result, this sector is not growing in line with the needs of farming communities and national development goals for the commercialization of agriculture. In fact, a review of all the government policy documents reveals there is no policy on agricultural mechanization in Nepal.

The introduction and adoption of modern technologies started after 1950 when the country opened up to the outer world. However, this sector is yet to get priority in the national planning process (Bajracharya et al. 2006). Even the APP does not mention agricultural mechanization.

Budget speeches since 1996–97 mention some policies and measures to import agricultural machineries and tools, which directly or indirectly encouraged private sector to engage in the business of these items (Adhikary 2003). The tenth five-year plan, which is also supposed to be the Poverty Reduction Strategy Paper (PRSP), is considered to be instrumental in achieving poverty alleviation. It identified broad-based economic growth, commercialization and modernization of agriculture, social sector development targeted programs, and good governance as major pillars, but failed to mention agricultural mechanization.

It is estimated that more than 85 percent of tools and implements used by farmers, especially in hilly areas, are made and repaired by local blacksmiths and rural artisans. Traditional wooden tools and implements, manual or animal-drawn, have remained in use in the hills and mountains for a variety of reasons, such as lack of electricity, small landholdings, narrow terraces, and the low purchasing power of farmers. Paddy shellers and polishers and mechanical grinding mills are adopted in the majority of villages in the Terai and hills but not in many mountain villages (NARC 2008).

Big machineries are limited mostly to the Terai region of Nepal. However, selective semi-mechanization of various agricultural operations has become a necessity; agricultural operations increasingly depend on aged people and women laborers because of the migration of young people in search of employment abroad.

Government research and development (R&D) on agricultural mechanization is centralized, top-down, and isolated, and it fails to respond to the needs of clients in diverse agroclimatic and sociocultural contexts (Gurung and Justice 2002).

POLICY AND PRACTICES FOR SEED AND AGRICULTURAL INPUTS

The policies and practices related to the seed and agriculture input industry have been analyzed in relation to the terms of reference of the study.

What is the current structure and impact of the public agricultural research and extension systems in Nepal, and how do these public systems contribute to improving the ability of small-scale, resource-poor farmers (smallholders) to access new technologies?

Nepal has set up institutions for the delivery of research and extension. Although the NARC research network covers all three agroecological regions, the majority of research stations are located in the Terai (NARC 2010). Similarly, some research stations in the Terai are not in appropriate locations.

Only one-third of maize and wheat varieties and around 60 percent of rice varieties released by the NSB are actually in production as evidenced by indents (i.e., orders) for foundation-seed. This suggests a mismatch between farmers' requirements and the technologies on offer. Most crop technologies recommended by NARC are introduced from external sources and focused on a single commodity with little consideration of farming systems and business perspectives.

Given the agroecological and socioeconomic diversity in the hills and mountains, the number of research stations is inadequate and not representative, particularly of the conditions experienced by a large proportion of small-scale resource-poor farmers. Even now, both research and extension systems are target-oriented rather than outcome-oriented. NARC is not involved in scaling-up and disseminating technology except for on-farm testing and demonstration in outreach sites.

The Department of Agriculture (DoA) has a presence throughout the country right down to the grassroots level known as *Ilaka.*[13]However, after 1990, extension policy from the training and visit system[14] changed to a service on-demand approach: farmers are now required to visit Agricultural Service Centers and Sub-Service Centers to seek advice, place demand for new seeds, saplings, and so on. As a result, service delivery by DoA has also become weaker. Subsistence farmers, particularly from remote areas, tend not to like this approach and cannot afford to visit these service centers located in far-off locations.

It is common in Nepal for farmers to learn about technologies more through farmer-to-farmer networks (as farmers are organized in groups) than through formal extension. Similarly, demand for crop varieties comes from farmers once varieties have become popular rather than from advertisement and promotion efforts by the extension service (Joshi et al. 2005).

In spite of this institutional structure, the impact of public research and extension in Nepal is not encouraging: the growth rates of production of all major cereals are lower than the population growth rate in the country (Gulati et al. 2010).

Conversely, average experimental yields of all three cereals are more than 4 tons per hectare, whereas average national productivity of rice (2.7 tons per hectare), maize (2.1 tons per hectare), and wheat (2.2 tons per hectare) is far less to support current population growth rate in the country. The difference between experimental and farmers' yields can be attributed to genotype by environment interaction caused bydifferences in the level of various crop-management factors at NARC's research station and in the farmers' fields (Witcombe et al. 2005).

[13] *Ilaka* refers to a sub-division of a district comprising a number of village development committees that are supposed to improve service delivery to the people.

[14] The training visit system involved intensive training of subject matter specialists and farmers. Regular visits and meetings followed up on the status of planned activities in the field. The approach is quite resource- intensive, but nevertheless maintained a lively relationship between farmers and extension agencies.

All research outcomes from NARC should be disseminated by the DoA through its extension network throughout the country. However, there is a lack of coordination between the two major government departments. As a result, delivery of research outputs to clients gets delayed.

Coverage of NGOs and special projects focused on agriculture has also contributed to the process of improving the ability of small, resource-poor farmers to access new technologies. However, operations by many projects and NGOs are of a more time-bound nature and may be not be sustainable in the medium- to long-term.

Discussion with the Joint Secretary, MOAC revealed that the government is now winding up APP to develop a new Agriculture Development Strategy (ADS). One of the major shortcomings in APP was a disregard for maize and wheat in its mandate, as these are the two most important cereal crops after rice, and vital in terms of food security. Not including maize as a priority crop by APP—a staple in the hills and mountainous areas for meeting the food needs of nearly half the population in the country—was a major gap.

APP was considered as the growth framework. To generate growth in the agriculture sector, it developed a strategy of packaging inputs, infrastructures, and efforts in certain geographical areas for certain commodities. Such areas, where there have been consolidated efforts towards promoting a particular commodity, are called "pocket areas." The strategy for consolidating the effort is known as the "pocket package strategy" (Nepal, Ministry of Agriculture and Cooperatives 2002). In a country like Nepal with its small-scale production, confining development efforts to a few pockets could not have produced meaningful outcomes. It is not surprising that APP failed and had to be wound up three years in advance of completing its mission.

Moreover, since APP was multi-sectoral, its success depended on the participation of, and highest level of coordination among, at least three line ministries: Ministry of Agriculture and Cooperatives, Ministry of Local Development, and Ministry of Water Resources and Irrigation. Although the Joint Secretary, MOAC did not speak of APP's failure, he did mention the plan fell far short of meeting all the targets. The major reasons cited were lack of coordination among line ministries, lack of resources, and disruption of development activities due to the Maoist insurgency.

Crop improvement, development, and spread of new crop varieties: The Seed Act is yet to be fully implemented in the entire country. It has provision for three certification schemes: (1) compulsory certification scheme involving tagging of seed lots by the seed inspectors, (2) Quality Declared Seed System, and (3) truthfully labeled (TL) seed. The Seed Quality Control Centre (SQCC), which is responsible for seed certification, has limited human resources and infrastructure to support emerging seed production and marketing activities by small seedenterprises and the private-sector seed industry—should they wish to use a compulsory certification scheme in terms of technical backstopping in seed certification. The latter two options are less promoted by government line-agencies, although they have more flexibility in terms of seed production and quality management: since the entire responsibility for managing seed quality lies with producers, they would be appropriate for improving access of small-scale, resource-poor farmers to the new seed varieties.

The National Seed Policy (NSP) 1999, which was instrumental in shifting policy for variety release and registration, was endorsed by MOAC in 2005. It has encouraged the private sector and NGOs to engage in crop breeding and seed trade. NSP recognizes data generated using participatory varietal selection trials (PVS)—typically Mother and Baby trials. It also specifies multi-stakeholders' preference criteria—not only consumers but also processing industries and other actors in the value and market chain—as requirements for release. In this way, the release process is more client-oriented and participatory.

However, there are areas where NSP needs to be amended. Particularly important are (i) formation of an independent high-level body within NSB to oversee the entire function of conducting variety trials to generate data for DUS, including for varieties developed by NARC and other breeding companies and institutions in the country; and (ii) changing the composition of the Variety Approval, Release, and Registration Committee (VARRC) by including independent professionals from the private sector and

academia to reduce the dominance of the NARC scientist. The farmers' seed system (particularly for food crops) has continued to be dominant in the country for the last several years, but gradually things are beginning to change. Following NSP, 16 private seedcompanies, and several functional small seedenterprises and cooperatives have emerged, which now have a transaction volume almost four times greater than that of state-run NSCL.

This is encouraging in terms of meeting seed demand for OPVs of major cereals within the country. However, the major problems with the private sector are (1) limited working capital, and (2) limited technical knowhow, including business development and marketing skills. These need to be addressed for the growth of these enterprises so they can contribute to improving crop productivity. Capacity building of this kind by some known professionals from successful business houses or universities could become a common agenda. In addition, SSEs, cooperatives, and DISSPRO groups need improved skills for institutional strengthening, bookkeeping, transparency, and capital formation through shareholding arrangements.

NARC as a government institution is highly influenced by political intervention and frequent changes in leadership leading to instability and uncertainty. In 20 years of NARC history, there have been more than 15 executive directors. Frequent changes in the leadership of crop-commodity programs and other scientists also pose a big problem in giving continuity to the research themes. A constraint of resources, including human resources, is another bottleneck with the council (NARC 2010).

While NARC struggles to cope with its mandate due to the shortage of resources, the government created the National Agriculture Research and Development Fund (NARDF). Principally, NARDF was created to promote public–civil society collaboration, increase competition in the research and delivery system, and support more demand-led and participatory initiatives through the provision of small grants. However, in practice, it has not been effective owing to a weak monitoring and evaluation system, and no mechanism for accountability and institutionalization of outcomes from projects. Should it remain as a framework to administer short-term actionresearch and dissemination projects designed for high impact, it would need to be managed by an independent body, and not by the MOAC. Alternatively, NARDF could be part of Poverty Alleviation Fund (PAF), which has wider scope for poverty alleviation and could be seen as a more cross-cutting and poverty focused than NARDF.

What is the current structure of the seed and agricultural input industry in Nepal, particularly with respect to competition and innovation?

Commercialization and modernization of Nepalese agriculture is still slow. The government corporation AIC and its derivatives enjoyed a monopoly in terms of cereal seed production and distribution, as well as fertilizer transactions, until the end of the last century. Both AICL and NSCL are now in the process of privatization- in a true sense - due to their extremely poor performance.

Seed industry*:* There are no published data on the market share of various actors involved in the cereal seed industry. However, private-sector actors, private seedcompanies, village-based small seed enterprizes (SSEs), Agrovets, cooperatives and also groups organized by the Department of Agriculture's Crop Development Directorate are the important players. For last 10 years, there has been increasing competition between various actors involved in the cereal seed business. This sector is now becoming increasingly dynamic and innovative. A number of new seed companies are currently being created with potential research components.

In the formal seedsector, ordinary farmers' groups tend to become cooperatives once they understand more about business and the importance of shareholding. From cooperatives, the natural pathway leads to private companies (Witcombe et al. 2010).

In the past, hybrid varieties of maize and rice were sold in the market without following any of the procedures required by the Seed Act and NSP. Recently, however, following a failure of a winter-planted maize hybrid in the Terai, government line agencies were strict in enforcing the provisions of the Seed Act. These emerging phenomena have the potential to influence a competitive environment, including possible innovations that may help increase the choice of crop varieties that could ultimately improve crop productivity.

The performance of NSCL is totally unsatisfactory as it was producing such a small quantity of seeds in relation to the luxury of infrastructure, human resources, market networks, and government support it enjoys.

Seed producer groups organized by District Agriculture Development Offices through DISSPRO are yet to develop business development and marketing skills. Quantities of certified seeds produced by these groups are low in proportion to the large volume of foundation seeds that they use. How much seed is actually sold by these groups and where it is sold remains unclear.

Foundation seed indent for hills and mountains is done through DADOs as they are the major players in those areas due to limited business opportunities for private-sector engagement. Private-sector organizations, concentrated in the Terai, produce most of the foundation seed. This is an efficient strategy for producing source seed for further seed production as production costs in the Terai are lower.

No private-sector organizations demanded foundation seeds of any of the three major cereals for seed multiplication either in hills or mountains. This suggests that seed business potential in these areas is still weak and that the establishment of sustainable seedenterprises in the hills is still far from reality. Farmers' cooperatives and SSEs (where feasible) will need to be formed to deal with this important issue, and they would need to be put in direct contact with resource centers for source seed. However, channeling foundation seed through DADOs will increase dependency of SSEs and cooperatives on them, and hamper the process of institutionalization.

Popularization of new varieties: Use of innovative techniques for popularizing new varieties such as advertisements on FM radio in regional languages, use of multi-stakeholder meetings, and large numbers of demonstrations is uncommon. DADOs use conventional methods of promoting new varieties, such as a few Minikits, but without any follow-up or feedback. Moreover, researchers do not see varietal popularization as one of their immediate responsibilities (Joshi et al. 2008). In Nepal, due to the dominance of the informal seedsystem, demand for crop variety depends on how widely they are known and used already. Thus demand is created due to popularity rather than relative merit; such a system favors production of outclassed varieties unless a systematic advertisement campaign for new varieties is in place (Witcombe et al. 2008). New varieties are less in demand largely because farmers are not aware about the better options available.

Fertilizer sector: The Government of Nepal tried to deregulate the fertilizer trade to open the commodity for private-sector actors. Fertilizer Control Order 1999 and National Fertilizer Policy 2002 provide regulatory frameworks for the liberalization of this essential commodity. But the policy did not work in Nepal for a variety of reasons, particularly the availability of highly subsidized fertilizers from India through informal trade. However, analyzing the situation from the perspective of food security in Nepal, it appears that Nepalese farmers are largely benefiting from this informal trade of fertilizers: it is one of the important elements contributing to high crop productivity in the Terai. The informal flow of fertilizers could change at any time. Thus, there should be serious efforts by the government to have a reliable system of fertilizer supply in place to avoid any unforeseen disaster affecting crop productivity and food security.

Discussions with vendors and farmers revealed that nearly half the fertilizers informally brought from India tend to be of low grade. This is the major concern for farmers—how to regulate the quality of fertilizers that come informally from India. This issue is rather difficult to address, but possible measures include:

- Legalizing the import of NPK from India through bilateral talks between the two governments
- Using the former fertilizer-subsidy funds to enforce better quality control of informally imported fertilizers

Moreover, distribution of subsidized fertilizers through cooperatives addresses food security of small-scale, resource-poor farmers, but most of the target farmers (smallholders) from remote areas fail to

have access to subsidized fertilizers; staff members of cooperatives often siphon off fertilizers to other vendors in return for financial incentives. Ultimately, the purpose of the government to provide subsidized fertilizers to smallholder farmers is more or less defeated.

Use of fertilizers on food grains in the Terai has the following value-cost ratio: rice 2.51, wheat 2.21, and maize 2.18 (Pandey 1991). Although these are old calculations, they are still meaningful, and this is why farmers are keen on using chemical fertilizers on their crops as long as it's profitable. Examples from other countries indicate that subsidizing fertilizers is not always a bad thing; a case study from India indicated that each US$1 spent on subsidizing fertilizer contributed US$4.4 to agricultural GDP. Farmers in Manang also estimated that about NRS 26 (US$0.39) subsidy per kilogram of fertilizer increased crop yield up to 30 percent. However, to have full benefit of such a program, significant improvement in government public goods such as transportation, communication, irrigation, and financial supports is essential. Many hill and mountain districts are yet to be fully connected with all-weather roads, and this limits the transporting of fertilizers to those areas. Similarly, lack of access to irrigation also limits the use of purchased inputs on agriculture.

Considering the poor performance of the AICL and NSCL, the government was preparing to privatize both the companies in a public-private partnership model. This is the right step forward and should be done without further delay to minimize the potential loss and impact of their poor performance on overall agricultural growth. It may well help the AICL improve services to clients.

Fertilizer trade in Nepal is greatly influenced by informal trade of highly subsidized fertilizers from India. The number of actors in *formal* import is virtually nil except the AICL; more vendors are involved in *informal* trade of fertilizers, particularly product from India. It is unlikely that this situation will change in the near future without a major shift in government policy.

Here are some possible options to address the widespread problems in the country:

- Supplying required fertilizer—currently 180 tons are supplied despite a demand for 580,000 tons, as well as meeting fertilizer needs for crop intensification and commercialization of agriculture.
- Imparting business development services and marketing skills to key providers of agricultural inputs suppliers, such as Agrovets, cooperatives, private companies, and small seed enterprises
- Ensuring the new policy that will likely target organic manure as a major source of plant nutrients (particularly for remote hilly and mountainous areas) considers preparation, storage, and use of organic manure through training, demonstration, and more research.
- Exploring the introduction of a voucher system for distributing fertilizers as found in other countries such as Malawi; this could also involve the provision of improved seeds of farmer-preferred and locally-adapted crop varieties.

TABLE 5.1—INDUSTRY STRUCTURE IN NEPAL IN RELATION TO SEED AND AGRICULTURAL INPUTS

Agricultural services	Involvement of different sectors			Overall structure	
	Public	*Private*	*Civil Society*	Of competition	Plurality
Terai, river basins and low hills (up to 1,000 m)					
Agricultural research	High	Low	Medium	Medium	High
Agricultural extension	High	Low	High	Medium	High
Seed supply	Medium	High	Medium	High	High
Fertilizer supply	High	Medium	None	Low	Low
Pesticides supply	Low	High	None	Low	Low
Machinery supply	Low	High	Very low	Low	Low
Hills and mountains (above 1,200 m)					
Agricultural research	High	Low	Medium	Low	Low
Agricultural extension	High	Low	High	Low	Low
Seed supply	High	Low	Medium	Low	Low
Fertilizer supply	Medium	Low	None	Low	Low
Pesticide supply	Low	Low	None	Low	Low
Machinery supply	Low	Low	Very low	Low	Low

Source: Produced by the authors, 2011.

How does industry structure affect the ability of small-scale, resource-poor farmers to access new technologies?

Emergence and growth of private-sector players in the agriculture input industry is a positive development. However, their geographical coverage is a matter of concern that affects the ability of smallholders to access new technologies. Most Agrovets and private companies are concentrated in the Terai. The number of private agriculture input-suppliers in the hills is thin and most of them are limited to district headquarters. This means that resource-poor farmers who live in remote areas of the district have limited ability to access new technologies and inputs that are supplied commercially. The other pertinent consideration is that since the motivation for private-sector actors is higher profit-margins, their limited presence in remote rural areas is understandable; there may not be enough business for them to be viable entities in rural areas. Use-level of agricultural inputs is dependent on commercialization or semi-commercialization of crops. When farmers start producing for markets, they tend to opt for higher input-use, as the perceived cost–benefit ratios change. Facilitating farmers' access to markets and traders for their crops by improving road infrastructure, as well as imparting business and marketing skills, will help change the current pattern of input use.

Although APP, NAP, and TYIP have all clearly mentioned commercialization and modernization of agriculture, they have yet to be translated into reality for a variety of reasons.

Most small-scale, resource-poor farmers live in remote rural areas. Easy access to transportation is one of the important considerations for their access to both new innovations and technologies, as well as more remunerative markets for their products. In Nepal, more than 60 percent of road infrastructure is located in the Terai, and some 10 districts are still not connected to any drivable roads. In many districts, roads end at the district headquarters. On average, rural households require more than two hours to reach their nearest markets, whereas urban households often only require 20 minutes (Nepal, National Planning Commission 2004). An assessment considered eight indicators related to service delivery, including functioning agricultural extension service, revealed the delivery of basic service was unsatisfactory with most VDCS in the country having moderate to poor service. Only a few VDCs, predominantly in the Terai and lower hills (accessible areas), were classified as having good service delivery (WFP 2010).

A key informant survey with Agrovets in the Terai districts indicated there is no difference across wealth categories in terms of farmers' access to agricultural inputs.

Small- and medium-sized farmers constituted nearly 84 percent of all customers (63 percent medium and 21 percent poor) of Agrovets. These data mostly agree with the official figures which say that 75 percent of all farmers own less than 1 hectare of land.

The study also looked at the distances served by an Agrovet or other vendors in terms of supplying agricultural inputs. Findings show that most farmers come to access inputs from within a distance of 15 km. Increasingly in the Terai, more Agrovets are emerging in the villages: although the choice of agricultural inputs may not be good, they do provide most of the major chemicals in demand.

The present study showed that DADOs are the predominant service providers in the hills and mountain districts. The few Agrovets and other private-sector agencies present in the hills are limited to the district headquarters for the obvious reason of lack of adequate business volume in the rural areas. The service model of DADOs changed about 20 years ago from a training and visit system to a supposedly service on-demand approach. In the latter approach, farmers are required to visit Agriculture Service Centers (ASCs) or Sub Service Centers where government agricultural technicians are stationed. DADOs neither are business enterprises nor do they produce any agricultural inputs. They act more as intermediaries between producers/private-sector input-suppliers and farmers. Findings from a case study in the hilly and mountain areas revealed the current extension approach of the government is not effective, particularly due to the difficulty of transportation and communication, unavailability of technicians when people visit them, and also a lengthy process to acquire inputs.

The overall effect of industry structure on the ability of small-scale, resource-poor farmers to access new technologies is summarized in Table 4.2. It is obvious that most of the desirable technologies are not readily available in country, although may be easily found in South Asia. Of technologies available in the country, new seed varieties and other agriculture-related technologies are more appropriate, available, and affordable while technologies related to fertilizer–nutrient management, pesticides, integrated pest management (IPM) and new machinery-related technologies are not exactly appropriate or readily available (Table 4.2).

TABLE 5.2—INDUSTRY STRUCTURE AND SMALLHOLDER ACCESS NEW TECHNOLOGIES

New technologies	Accessibility to Small-scale, resource-poor farmers			
	Existence of new technologies in Nepal (Yes/No)	Appropriateness (High/Medium/Low)	Availability (High/Medium/Low)	Affordability (High/Medium/Low)
Seeds of new varieties	Yes	Medium	Medium	Medium to high
Fertilizers/nutrient management technologies	Yes	Low	Low	Medium
Pesticides/IPM	Yes	Low	Low	Medium
New Machinery or equipment	Yes	Low	Low	Low

Source: Authors.

Policy options

Policy options

In the context of Nepal, the major question would be to find appropriate mechanisms to improve supply of important agricultural inputs—improved seeds of farmer-preferred varieties, fertilizers, irrigation equipment—all over the country at affordable prices.

One possibility could be to divert the subsidy on food aid to subsidize agricultural inputs instead through a liberalized market until the country can come out of its chronic food deficiency.[15] Subsidy is not always a bad thing; there are successful examples from Asia and Africa to support subsidies for a short period and a defined goal. Nepal already requires substantial food aid to distribute to chronically food-deficit areas; this has adversely affected local productionsystems as farmers are now becoming more dependent on food from WFP. Any program to strengthen the local production system, even with a start-up subsidy package, would be desirable from the point view of sustainability. Nepal could explore a voucher system for distributing fertilizers and improved seeds since it have been found

[15] Currently, the Government of Nepal provides US$25 million annually to WFP for providing support to 1.8 million people across Nepal for preventing hunger and meeting food and nutrition needs (WFP 2011).

useful in other countries such as Malawi. This could start with a substantial subsidy, which would be reduced and then phased out.

Since there are no other viable business alternatives to improve access of smallholders living in remote rural areas, the creation and strengthening of smallholders' cooperatives that deal with input and output marketing could be an option. This should be given priority in all new policy and regulations as it increases the stake of all shareholders. Although the cooperative movement as such in Nepal is not without problems, there are several success stories worth pursuing.

Some opportunities for improving access of small-scale and resource-poor farmers to new technologies and innovations have been listed below:

Opportunities for poverty reduction through public investment in agriculture research and development and infrastructure

Nepal's agriculture research and development sector suffers from lack of funding. Resource constraints stem from internal conflict and lack of any external funding on agriculture; the Ministry of Agriculture and Cooperatives received a 2.4 percent share of the total national budget in 2008–09 compared to 3.7 percent in 1997–98. Within the budget for agriculture, the proportion for NARC also declined from 14.4 percent in 1997–98 to 7.1 percent in 2008–09 (NARC 2010). However, it is gradually beginning to increase in more recent years with national government support (Rahija et al. 2011).

Analysis of return on public investment in various sectors may be needed for refining overall government investment plans. However, IFPRI's research indicated that public investment on infrastructure such as rural roads, and in agriculture research and development and education, can significantly reduce poverty. Increasing share of funding to impoverished and previously unserved regions can be truly a pro-poor public investment to generate income in rural areas; it can create positive impacts on agricultural profitability, agricultural wages, rural non-farm employment, and overall poverty reduction (Renkow 2010). Other findings also indicate that returns on investment in agricultural research are higher than with traditional investment (Fan et al 2008). Declining resource allocation to agriculture research and development will have direct implications on attaining the objective of poverty reduction, despite investment made on infrastructure (roads, credit provisions, and so on).

There are opportunities to make the national research system more dynamic and responsive to the needs of smallholders and help address food and nutrition security in Nepal, such as by improving the analytical capability of institutions and their commitment to implementation. Lack of institutional capacity for policy analysis is one of the biggest constraints in the country, resulting in inappropriate polices and too-frequent changes in policy instruments.

One of the biggest problems in Nepal is related to the implementation of research and development activities. This directly affects farmers' access to improved seeds, technologies, inputs, and services. Major challenges are as follows:

- Lack of political commitment
- Lack of coordination
- Lack of resources

Implementation processes suffered during the insurgency as much they do in the current transition. The new emerging problems now are the following:

- Lack of political consensus due to extreme political polarization
- Financial misappropriation and corruption
- Obstruction of development by various interest groups and trade union activities by the labor organization affiliated with political parties

- Weakening law and order

Seed-based technologies are the easiest and cheapest means of increasing crop productivity. For the farmer, the genetic improvement of crops offers the most cost-effective means of increasing or maintaining profitability (PBI 1990), and this is even more important for smallholders given their limited capacities to invest in purchased inputs and technologies. Over the past 50 years, the varietal contribution to total world food output increased by more than 50 percent (Tanksley et al. 1989). Even to provide full benefits of this potential to farmers, strengthening the agriculture research and development capability of NARC, an agricultural university—including NGOs in agricultural research and development—is one of the main priorities.

Data recording and usage: governmental statistics deal only with official data maintained by line ministries and departments. Since the private sector is the major actor in the import and sale of all agricultural inputs, any records that fail to include private-sector data will be incomplete, and any analysis and policy formulated on such incomplete information will be misleading. Data on seeds and fertilizer use are two important examples of discrepancies.

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ANNEX

Abbreviations

ADS	Agricultural Development Strategy
AIC	Agricultural Input Corporation
AICL	Agricultural Input Company Limited
AIRC	Agriculture Implements Research Centre
APP	Agriculture Perspective Plan
ARS	Agricultural Research Station
ASPR	Agricultural Sector Performance Review
CARIAD	Centre for Advanced Research in International Agricultural Development
CBD	Convention on Biological Diversity
CBS	Central Bureau of Statistics
CEAPRED	Centre for Environmental and Agricultural Policy Research and Development
CIMMYT	International Maize and Wheat Improvement Centre (Rice-wheat consortium)
COM	Council of Ministers
DADO	District Agriculture Development Office
DAP	Diammonium Phosphate
DoA	Department of Agriculture
DoAB	Division of Agricultural Botany
DUS	Distinctness, Uniformity, and Stability
ECCA	Essential Commodity Control Act
EIA	Environmental Impact Assessment
ELISA	Enzyme-Linked Immune-Sorbent Assay
FCO	Fertilizer Control Order
FFS	Farmers' Field Schools
FORWARD	Forum for Rural Welfare and Agricultural Reform for Development
GDP	Gross Domestic Product
GHI	Global Hunger Index
GMO	Genetically Modified Organism
HI	Hunger Index
HMGN	His Majesty's Government of Nepal
ICAR	Indian Council for Agricultural Research (All India Coordinated Rice Improvement Project)
IEE	Initial Environmental Examination
IKT	Indigenous Knowledge Skills and Techniques
IPGRI	International Plant Genetic Resources Institute
IPM	Integrated Pest Management
IPNMS	Integrated Plan Nutrient Management System
IRRI	International Rice Research Institute
LI-BIRD	Local Initiatives for Biodiversity, Research, and Development
LRMP	Land Resources Mapping Project
MAS	Marker-Assisted Selection
MDG	Millennium Development Goal
MFSC	Ministry of Forest and Soil Conservation
MOAC	Ministry of Agriculture and Cooperatives
MOP	Muriate of Potash
MPI	Multidimensional Poverty Index
NAP	National Agricultural Policy
NARC	Nepal Agricultural Research Council
NAST	Nepal Academy of Science and Technology
NBC	Nepal Biosafety Committee
NBCC	National Biodiversity Co-ordination Committee
NDRI	National Development Research Institute
NEAT	Nepal Economic Agriculture and Trade
NeKSAP	Nepal Food Security Monitoring System
NGOs	Nongovernmental organizations
NLSS	Nepal Living Standard Survey
NPC	National Planning Commission
NRRP	National Rice Research Programme
NSB	National Seed Board
NSCL	National Seed Company Limited
NSP	Nepal Seed Policy
NVP	Nuclear Polyhydrosis Virus
OPHI	Oxford Poverty and Human Development Initiative
OPV	Open-Pollinated Variety
PPD	Plant Protection Directorate
PPP	Purchasing Power Parity
PRMD	Pesticides Registration and Management Division
PRSP	Poverty Reduction Strategy Paper
PVS	Participatory Varietal Selection Trials
R&D	Research and Development
RARS	Regional Agricultural Research Station
RIUP	Research into Use Programme
SDC	Swiss Agency for Development and Cooperation
SUPPORT	Social Uplift through Participatory Programmes, Research, and Training Foundation
TU	Tribhuvan University
TUTH	Tribhuvan University Teaching Hospital
TYIP	Three-Year Interim Plan
TYP	Three-Year Plan
UNDP	United Nations Development Programme
UPOV	International Union for the Protection of New Varieties of Plants
USAID	United States Agency for International Development (USAID)
WFP	World Food Programme

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