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Working Paper #11-5

September 28, 2011

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Abstract

Nepal faces multiple development challenges, including chronic and widespread food insecurity and adult and child malnutrition. Due to population growth, agricultural stagnation and a range of institutional failures, the threat of a serious food crisis in Nepal is substantial. The recent scaling back of WFP assistance means that food security conditions in some parts of Nepal will undoubtedly worsen in the near future. This paper presents a brief review of topics and available evidence regarding food security, malnutrition and related subjects in Nepal. It is intended to document important source material and provide an overview of topics for non-specialists or those moving into new areas of concern.

Keywords: Agriculture, health, nutrition, Nepal

JEL Codes: I12, I31, O19, Q18

This work was made possible through support provided by the Bureau of Economic Growth, Agriculture and Trade, U.S. Agency for International Development through the Global Nutrition Collaborative Research Support Program. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the sponsoring agency. Patrick Webb and Shibani Ghosh provided helpful suggestions and input on an earlier draft.

Introduction

Nepal faces multiple development challenges, including chronic and widespread food insecurity and adult and child malnutrition. As a result of rapid population growth, agricultural stagnation and a range of institutional failures, the threat of a serious food crisis in Nepal is substantial.[1] Nepal's most recent (2010) Global Hunger Index (GHI) score is 20, which places it 27th out of 84 ranked countries; western regions of the country score far lower (Hollema and Bishokarma, 2009). Government expenditure on agriculture is currently the lowest it has been in decades, and the country has recently experienced substantial food grain deficits of 225,000 mt in 2007 and 133,00 mt in 2009 (Hobbs, 2009). The World Health Organization (WHO) places the current malnutrition rate at "crisis" level, and a recent World Food Program (WFP) report notes that the country suffers from the worst malnutrition in Asia, on par with the Democratic Republic of the Congo, Sudan, Uganda, and Somalia (Hobbs, 2009).With more than 3.5 million people moderately to severely food insecure, many of them in regions geographically remote and difficult to reach, food aid has played a prominent and growing role in meeting food needs in recent decades (Frankenberger et al., 2010). However, according to recent media reports, reduced funding resulting from the global financial crisis has forced cuts in many food assistance projects. The scaling back of WFP assistance, including the halt of helicopter and air operations used to fly aid into remote regions, is projected to decrease the number of those receiving food aid from one million to approximately 100,000,[2] suggesting that food security conditions in some parts of Nepal will undoubtedly worsen in the near future.

This paper presents a brief review of topics and available evidence regarding food security, malnutrition and related subjects in Nepal. It is by no means comprehensive in its scope or coverage, but is intended to document important source material and provide an overview of topics for non-specialists or those moving into new areas of concern. The material is organized under a series of broad thematic headings, although it is important to recognize that most of issues covered in the paper are interconnected both in their causes and their impacts. Throughout the paper, reference is made to data derived from the Nepal Demographic and Health Survey (NDHS). DHS survey data for Nepal are available for 2001 and 2006. Both surveys are nationally representative, geo-referenced and publicly available (see the Appendix for details). A current round of the survey is being collected at the time of writing, and will likely be made public in the next 12-18 months (by early 2013). The DHS data provide the most comprehensive assessment of nutrition outcomes available for Nepal.

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[1] The majority of districts in Nepal were estimated to be food insecure in 2007, and thirteen districts reported annual per capita cereal production below 150 kg/person. In decreasing order of deficit these districts are Kathmandu, Humla, Lalitpur, Bajura, Achham, Dolakha, Bhaktapur, Mahottari, Kalikot, Baitadi, Bajhang, Dolpa and Rautahat. In addition, fourteen other districts had per capita cereal production between 150 kg/person and 180 kg/person, significantly below the national average and below the level considered the minimum requirement for sufficiency (FAO/WFP, 2007).

[2] See reports by ABC and BBC at http://www.abc.net.au/pm/content/2011/s3220545.htm and http://www.bbc.co.uk/news/world-south-asia-13422384. The WFP program in Nepal is described at http://www.wfp.org/countries/Nepal/Operations.

Malnutrition, Food Insecurity and Health

Nepal is one of the least well-nourished countries in the world. According to data from the most recent Nepal Demographic and Health Survey (NDHS, 2006), half of all Nepalese children under the age of five have a low height-for-age or suffer from stunting as a consequence of chronic malnourishment. Approximately 40 percent are underweight. The highest rates of hunger are found in the Far- and Mid-Western Hill and Mountain regions. According to Hollema and Bishokarma (2009) Hunger Index scores in these areas of Nepal are close to or above 30, and no sub-region falls into either the *moderate hunger* or *low hunger* categories. Even so, and despite a highly unstable political environment, Nepal has made steps towards achieving improved health indicator targets as identified in the country's 10th five year planning period. These include reducing child and maternal mortalities (World Bank, 2010). As FAO data presented in Figure 1 indicate, both the number and the proportion of undernourished people in Nepal peaked in 1998. Nevertheless, about 15% of the population remained undernourished as of 2005. Recent data provided by the NDHS (see Figure 2) show a significant decline in the percent of children with stunted growth and a modest decline in the percent of children that are underweight. Despite these gains, the Millennium Development Goal to reduce the proportion of underweight children by 50 percent before 2015 remains elusive. A recent United Nations Children's Fund (UNICEF) report shows that 69 percent of Nepalese children are severely deprived of one or more of the seven basic necessities included in the Bristol index (sanitation, information, water, shelter, food, education, health) and 38 percent are severely deprived of two or more of these indicators, which is considered a marker of absolute poverty (UNICEF, 2010). Of particular concern are the indicators of malnutrition and sanitation. More than half of all children between 0 and 17 months of age lack access to any kind of toilet and suffer from the combined effects of insufficient nutrition and poor hygiene (UNICEF, 2010; Kohler et al., 2009).

Undernutrition is a nationwide problem in Nepal, but disparities across socio-economic groups and ecological regions are masked when looking at national aggregates. As an example, 54 percent of children under age five were found to be underweight in the lowest income quintile, compared with 24 percent in the highest quintile (MOHP, 2007). In terms of regions, 53 percent of children from the Mid-Western region were found to be underweight, in comparison to 37 percent of children from the Eastern region. Looking at the sub-regional level, child mortality ranges from a low of 4 percent in the Central Hill sub-region to 18 percent in the Western, Mid-Western and Far-Western Mountain sub-regions (Hollema and Bishokarma, 2009). From 1996 to 2004, poverty (as measured by a consumption index) declined from 42 percent to 31 percent in Nepal, largely due to a rise in remittance flows, higher non-agricultural incomes, increased urbanization, and fertility declines. However, large income disparities persist across ecological zones, urban and rural locations, and along gender, ethnicity and caste lines. Although the decline in consumption poverty has been accompanied by substantial reductions in child poverty over the same period (from 44 percent to 36 percent), 11 percent of children fall more than three standard deviations below the international reference population for weight-for-age, which is an indicator of severe malnutrition. Children in rural areas are disproportionately affected by malnutrition relative to their urban cohorts, with 51 percent vs. 36 percent stunted, and 41 percent vs. 23 percent underweight (Hobbs, 2009).

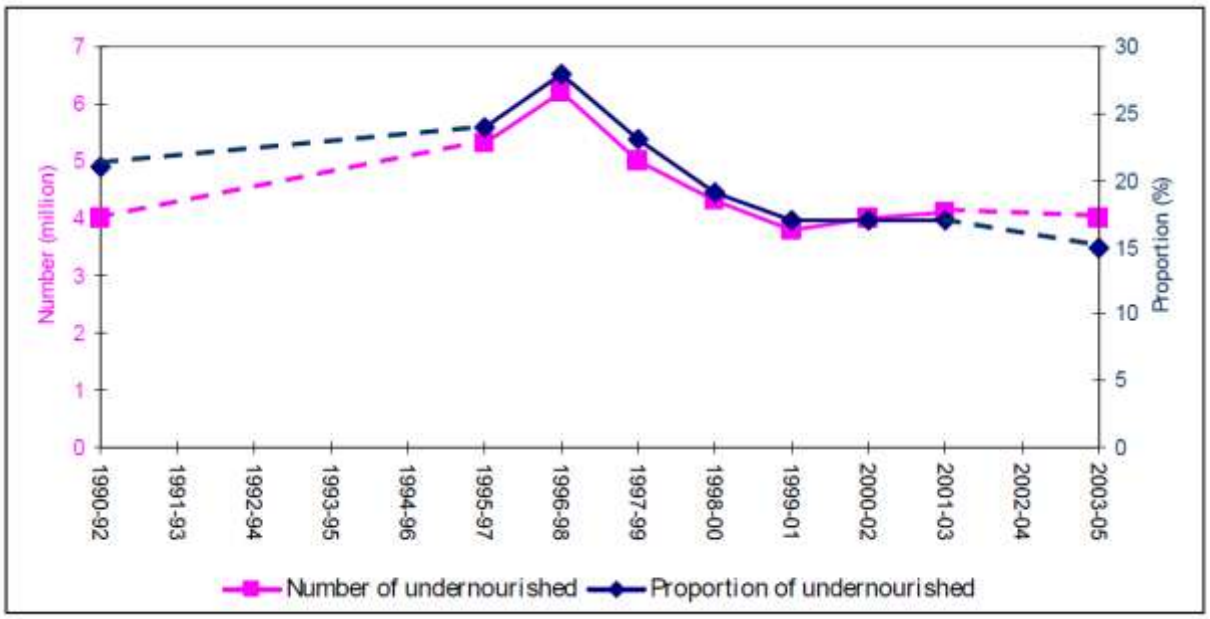

Figure 1: Trends in undernutrition in Nepal (Source: FAO, 2007)

Using livelihood as a marker, Romer (2004) identifies over 9 million Nepalese as vulnerable to food insecurity. Of these, the majority are marginal farm households located in the Hills and Terai, followed by rural castes, agricultural laborers in the Terai, marginal farmers in the Mountains, porters, and poor urban households. However, those most vulnerable to food insecurity are sub-populations within those groups, namely women, children, indigenous people, and those in the lowest castes. Low dietary diversity also is a concern. According to NDHS data, access to foods rich in vitamin A is severely limited. NDHS data from 2001 and 2006 show that, in the week leading up to the survey, fewer than one third of children below age three had consumed vegetables and fruits rich in vitamin A. Urban-rural disparities are also evident in the availability of fruits and vegetables rich in vitamin A. For example, 37 percent of urban children consume these foods compared to just 28 percent of rural children. Vitamin A supplementation is widespread in rural and urban areas of Nepal, although a somewhat larger proportion of children in rural areas receive direct vitamin A supplementation than in urban areas (80 percent vs. 75 percent) (Pradhan, 2005).

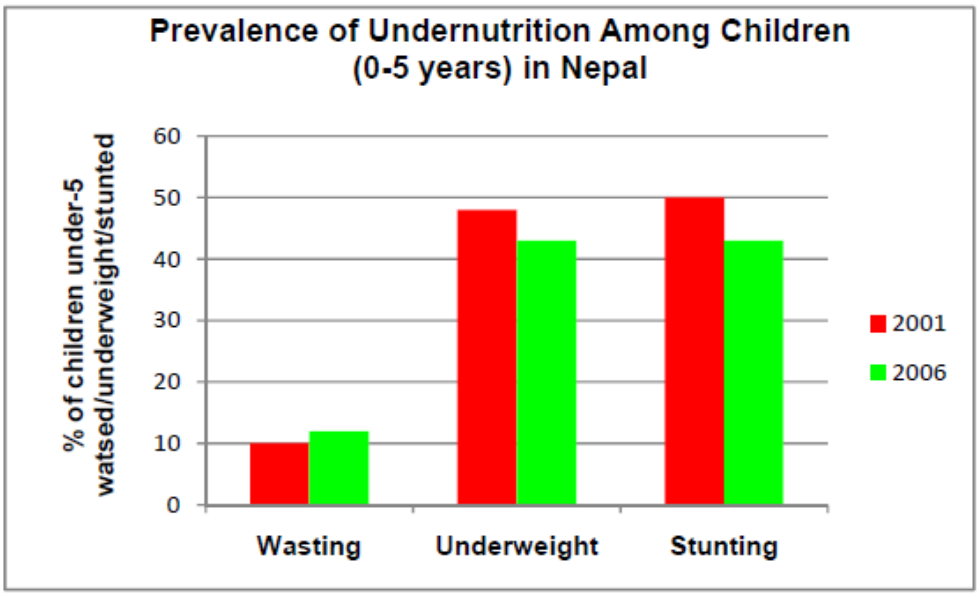

Figure 2: Child nutritional status (Source: NDHS data; figure from World Bank)

In an environment where one of every two children is already malnourished, the incidence and effects of diseases can be life threatening. With serious health implications, the most widespread severe deprivation faced by children in Nepal is lack of sanitation, which is a direct contributor to the disease burden. Nearly 6.4 million of Nepal's children (more than half) defecate in the open. This lack of sanitation has important ramifications for the spread of disease. Rural children are three times worse off than their urban counterparts (UNICEF, 2010). Those living in the Western Mountains, the Midwestern Hills, and the Central Terai suffer disproportionately. Over 70 percent of children in these areas defecate in open spaces. In addition to poor sanitation, 11.4 percent or 1.3 million children in Nepal lack access to a safe and adequate supply of water. The results of poor sanitation and unclean water include worm infestations (affecting nearly all children), typhoid (affecting 200,000 children in 2004), and a range of vector-borne illnesses including Japanese encephalitis and Malaria (UNICEF, 2010).

Rai, et al. (2002) provide a comprehensive overview of infectious diseases in Nepal and their links to malnutrition. Numerous infectious diseases are widespread in Nepal and according to the National Planning Commission (NPC) infectious disease is implicated in nearly three-quarters of all illnesses and deaths (NPC, 1998). Intestinal parasitosis is one of Nepal's most important public health problems. It is estimated that 60 percent of the population is infected with one or more species of parasite (Ishiyama, Ono and Rai, 2001), with infection rates as high as 90 percent in some rural areas (Estevez, Levine and Warren, 1983; Rai and Gurung, 1986; Rai et al., 2000a). Cholera outbreaks and infections of the small intestines peak during the rainy season (Ise et al., 1996).

Soil-transmitted helminthes, also known as intestinal worms, are the most common intestinal infection in Nepal (Adhikari et al., 1986; Rai et al., 1994; 2000a). The worms are so widespread that Rai et al. (2000b) report that even the soil in Kathmandu is contaminated with eggs. Additionally, it has been estimated that nearly 50 percent of otherwise healthy Nepalese (Rai, 1999) and most livestock (Rai et al., 1996) are infected with *Toxoplasma gondii*, a normally minor infection that can be fatal for fetuses and newborns. Throughout the Terai and in

villages along rivers, vector-borne diseases including malaria, leishmaniasis and Japanese encephalitis are endemic (Rai et al., 2001).

Few studies report comprehensive data regarding micronutrient nutrition in Nepal. The most recent national micronutrient status survey dates to 1998 (World Bank, 2010). That survey found low prevalence of night blindness (0.24 percent) and Bitots spots (0.33 percent), and low serum retinol levels among preschool children (32.3 percent).[3] These measurements indicate chronic lack of vitamin A consumption. Additionally, Iodine deficiency disorders such as goiter were present among 40 percent of the total population, and among 32 percent of tested preschoolers. The NDHS 2006 survey revealed high prevalence of anemia among women and children: 48 percent of children ages 6-59 months were reported as anemic (World Bank, 2010).

A key contributor to chronic undernutrition in Nepal is low weight at the time of birth. More than a third of Nepalese children suffer from low birth weight (LBW), which originates with poor maternal nutrition. Around a quarter of Nepalese women have a body mass index (BMI) below normal and about 36 percent of pregnant women are anemic. Another barrier to reducing the prevalence of underweight children is sub-optimal infant and young child feeding (IYCF) practices. Contrary to WHO's breast feeding recommendations, which call for exclusive breastfeeding up to 6 months, only 53 percent of Nepalese children under 6 months are exclusively breastfed. Recommended IYCF practices call for milk or milk products and foods from specifically recommended food groups and ask that infants are fed at least the recommended minimum number of times (World Bank, 2010). Almost all Nepalese children aged 6-23 months are breastfed or given milk products, but only 57 percent of children are provided with the recommended number of foods items (food from three or more groups for breastfed children), and 18 percent are fed less often than is recommended. Another factor that greatly contributes to childhood undernutrition in Nepal is poor access to safe drinking water and adequate sanitation (World Bank, 2010).

In 2007, the Government of Nepal undertook steps through the Department of Child Health Development (CHD) to end problems of child malnutrition through the drafting of the National Nutrition Action Plan (NNAP), which advocates for a comprehensive, integrated and inter-sectoral strategy for addressing the problem of malnutrition in Nepal. However, while it was an important effort from the government, the document has not been finalized. The Government of Nepal (GON) has made several efforts and interventions with different degrees of success to address the problem of undernutrition, including the establishment of a nationwide program for mid-day meals. Although the midday meal program has been judged as quite valuable for promoting education and school attendance, its record as a nutrition intervention program is less well established (World Bank, 2010). Nepal has implemented a National Vitamin A Programme (NVAP), a National Iodine Deficiency Disorders Control Programme (NIDDCP), and a number of programs aimed at supplementing iron and folate for pregnant and lactating women. The National Nutrition Policy and Strategy, which is administered by the Child Health Division of the Department of Health Services, strives to improve health and implement basic nutritional aids such as vitamin A supplementation. The distribution of vitamin A and other nutritional supplements is mainly done via Female Community Health Volunteers (FCHV) and Village Health Workers (VHW). Among other responsibilities, these groups also mobilize

[3] WHO uses a 0.5% prevalence rate for Bitot's spots and a 1.0% prevalence rate for night blindness as the lower thresholds for determining a public health concern.

communities to help with family planning, maternal care and child health. Other ministries in Nepal have been involved in nutrition-related plans within specific sectors. These include the Ministry of Agriculture, the Ministry of Education, and the Ministry of Women, Children & Social Welfare (World Bank, 2010).

Detailed malnutrition maps were developed and published jointly by the Nepal Central Bureau of Statistics, the World Food Program and the World Bank in September 2006.[4] These maps illustrate a high degree of overlap among wasting and underweight indicators; in contrast, stunting is far more prevalent in Mountain sub-regions. The maps underscore the considerable geographic diversity among nutrition indicators in Nepal. The highest incidences of stunting and underweight occur in the Mountain and Hill areas of the Far- and Mid-Western development regions. In these areas, 60 percent of children show signs of stunting and 50 percent register as underweight. These outcomes can be attributed largely to the limited availability of food and high underlying rates of poverty in these areas.

In the Terai, on average, 17 percent of children suffer from wasting, although rates as high as 21 percent are reported in the Central Terai. Both UNICEF and Action Contre La Faim (ACF) have conducted nutrition surveys in drought-affected Nepalese districts. The UNICEF report shows that 72 percent of children are stunted in Bajura district and 70 percent are underweight. In Jumla, rates of malnutrition are even more striking, with indications that 82 percent of children are stunted and 77 percent are underweight (FAO/WFP, 2007). Wasting levels recorded in these districts are also extremely high. A separate survey conducted in January 2007 by ACF in the district of Bajhang placed the chronic malnutrition rate at 59 percent (FAO/WFP, 2007).

A separate WFP survey, also conducted in 2007 in drought-affected areas, used measurements of mid-upper arm circumference (MUAC) to gauge malnutrition levels. Results show malnutrition rates in excess of 50 percent in these areas, with an additional 24 percent of children at risk (FAO/WFP, 2007). The same study investigated food consumption patterns and concluded that people in drought-prone areas do not generally consume diets rich in proteins, vitamins and minerals. According to the survey, households consumed fish, meat, eggs and fresh fruit very rarely. Furthermore, consumption patterns in areas affected by drought deteriorate sharply surrounding severe weather events. As an example, despite their role as basic ingredients in the Nepali diet, lentils and pulses were not consumed by more than half of households in drought-affected areas. On the other hand, only about 12 percent of households from non-drought areas had not consumed lentils and pulses. Similarly, the survey showed a reduction in the intake of green vegetables among households in drought-affected areas (FAO/WFP, 2007). Overall, households in these most vulnerable areas have few viable coping strategies; markets tend to function poorly, alternative sources of income and livelihood are rare and temporary or permanent migration is difficult. The message, therefore, is that households in areas prone to drought and other exogenous shocks must consequently internalize a significant proportion of these shocks through reduced consumption and subsequent degradation of nutrition and health.

[4] Three maps (one each for prevalence of stunting, wasting and underweight) are available at: http://www.un.org.np/sites/default/files/maps/tid_113/Malnutrition-Map.pdf

Agricultural Production, Livelihoods and Food Security

Income from farming remains a dominant source of income for a large majority of the rural population in Nepal, especially those located in the Mountain regions and many areas of the Hills and Terai. Data from the 2004 Nepal Living Standards Survey show that nearly half of household income comes from agricultural production. The second largest income source is non-farm wages (28 percent), followed by remittances (11 percent). The contribution of agriculture to overall income is lower at the national level than for the Mountain regions, where 60 percent of household income is derived from farming activities, with non-farm income just 19 percent and remittance income 9 percent. The poorest households rely disproportionately on farm income. The poorest and second poorest quintiles (based on consumption) derive 62 percent and 58 percent of their income, on average, from farming activities, and receive lower than average remittances (8 and 9 percent, respectively) (Floyd et al., 2003).

The most relevant ongoing problem in the Hills and Mountains of the Far and Mid-Western regions is simple lack of food. This problem is exacerbated by very low purchasing power and extremely high market prices in these remote locations. When these areas face food deficits they rarely see an influx of private supplies (FAO/WFP, 2007). Moreover, deficits tend not to be filled by national or international agencies because of extremely high transportation costs. These high costs prohibit the necessary quantities of food from being transported to these deficit areas. On the other hand, problems with food insecurity in the Terai and Lower Hills, which tend to be food-surplus areas, are related to distribution, access and purchasing power. These latter areas are characterized by lower rates of poverty than are found in the Hills and Mountains of the Far- and Mid-West; however, the concentration of poverty (as measured by the number of poor people per square kilometer) is quite high (FAO/WFP, 2007).

Most Nepalese have extremely limited purchasing power. According to the World Food Program's mission observations, income inequality tends to be higher in the Terai than in the Hills and Mountains, and groups that tend to be especially vulnerable (such as Dalits, Adivasi Janajatis and Kamayas) often struggle to access food in sufficient quantities. As a result, the Terai region is characterized by very high wasting levels, often above emergency levels. Due to the heterogeneity of Nepal's landscape, analysis of aggregated data is misleading. Unfortunately, disaggregated data are rarely available to provide better insight on food security within marginalized groups (especially within the Terai). These groups often suffer not just economically, but socially. They have limited knowledge regarding nutrition and appropriate hygiene and caring practices, and their views regarding gender divisions within the household tend to place women in disadvantaged positions vis-à-vis men (FAO/WFP, 2007).

From the perspective of food production, overall performance in Nepal is disappointing and agricultural productivity remains low by South Asian standards. A 2004 report by the Ministry of Agriculture (MOA) indicated that the main staple food crops in Nepal (wheat, maize, rice, and potato) were produced at only 50 percent of the maximum attainable yield; cereal yields are estimated to be roughly 2 tons per hectare. The primary reasons put forward for low productivity are a heavily reliance on rain fed production (roughly two-thirds of agricultural production is rain fed) and subsistence orientation. Population growth compounds these problems by reducing farm sizes over time.[5] The MOA reported that the sources of low yields

[5] Nepal's population growth rate peaked at 2.5% in 1996. As of 2009, the population growth rate

were low investment in irrigation, infrastructure, fertilizers, rural credit and rural power, as well as a lack of research into improving agriculture and very little coordination among government departments (Shrestha et al., 2008). As a result of these failures, the annual growth rate of agriculture remains quite low (below 3%). Not surprisingly, observers have pointed to increasing agricultural production, marketing and trade as pathways to reduce malnutrition in Nepal, with a specific focus on boosting agricultural activity in the remote areas of the Hill and Mountain regions. Although the economy includes services, small-scale manufacturing and tourism in addition to agriculture, the largest share of national income by far is derived from agriculture, which provides livelihood for more than 80 percent of the population and accounts for approximately 40 percent of Gross Domestic Product (FAO/WFP, 2007). Furthermore, much of the country's industrial activity is directly or indirectly related to agriculture and the processing of agro-industrial products. These products include jute, sugarcane, tobacco and grains. Given the current structure of Nepal's economy, economic development efforts must emphasize the agricultural sector.

Seasonal food shortages are quite common in many parts of Nepal, a pattern that is driven by sharp monsoonal influences in production, poor post-harvest storage and handling, and weak transport infrastructure and market integration (Sonogo, 2008). A crop calendar for Nepal's main cereal crops is presented in Table 1. This indicates strong temporal correlations of harvests within agroecological zones, but substantial negative covariance of production across agroecological zones. This latter feature provides some underlying opportunities for spatial and temporal gap-filling through internal trade, a potential that has not yet been realized. Panter-Brick (1993) demonstrates that the strong seasonal pattern of subsistence agricultural production in Nepal has important ramifications for women's activity and energy demands, especially during pregnancy and lactation. Levine (1988) reviews a series of case studies that provide insights into the relative work burdens and time allocation of women in mountainous areas of Nepal, concluding that, at all levels of income, women tend to place greater emphasis on productive activities than child care, and tend to organize the latter around the former. As a result, seasonal peaks in agricultural labor demand translate directly into time constraints for women and increased vulnerability for children.

In much of Nepal, prices for staple foods are strongly linked to corresponding prices in Indian markets, as the cereal markets in much of the Hill and Terai areas are integrated into those of Nepal's southern neighbor. The markets of the Mountain region are much more isolated, however, which leads to relatively higher rice prices there. From 2004 to 2007, prices for rice in the Mountain region were on average 177 percent higher than for the markets in the Terai region and were 123 percent higher than in the Eastern region (FAO/WFP, 2007). Additionally, households located in the Mountain regions spent as much as 65 percent of their income on food, compared with a national average of 37 percent (FAO/WFP, 2007). When undernourishment is measured in terms of insufficient caloric intake (using the CBS minimum of 2,124 kcals per day) the percentage of people that are undernourished at the national level is approximately 41 percent. As one might expect, the Western regions have a much lower average caloric intake than the rest of the country (2,310 and 2,250 kcal/day vs. 2,405 kcal/day for the country as a whole). The same basic geographic pattern holds for those considered to be severely undernourished (FAO/WFP, 2007).

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was 1.8% and total population stood at 29.3 million.

Such regional patterns lead Shrestha et al. (2008) to describe poverty in Nepal as a predominantly rural phenomenon related to a lack of decentralization of program planning and misallocation of resources in rural areas. As in many poor rural areas, individuals in rural Nepal suffer from inadequate calorie intake, widespread nutritional deficiencies, low rates of literacy (especially among women), poor employment opportunities, low provision of health services (including low levels of prenatal care), and limited access to safe drinking water. As a result, many young people attempt to migrate out of rural areas in search of employment in the towns and cities of Nepal, in India, or overseas. As part of this transition involving human capital moving out of rural areas, the nature of agricultural production has been changing and presents opportunities and challenges for agricultural development.

Table 1: Crop Calendar for Main Cereal Crops Cultivated in Nepal (Source: FAO, 2007)

Crop	Ecological Zones	Irrigation	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sept	Oct	Nov	Dec	Season
Paddy	Hills	Partially					TP	TP			H	H			Summer
		Year-round			TP	TP			H	H					Spring
	Terai	Rainfed						TP	TP		H	H	H		Summer
		Year-round			TP	TP			H	H	H				Spring
									TP	TP			H	H	Late summer*
Maize	Mountains	Irr./Rainfed			P	P				H	H	H			Summer
	Hills	Rainfed			P	P				H	H				Summer
		Irrigated		P	P			H	H						Spring
	Terai	Rainfed				P	P			H	H				Summer
		Year-round		P	P			H	H						Spring
				H	H							P	P		Winter
Millet	Mountains	Rainfed				P	P					H	H		Summer
	Hills	Rainfed						P	P			H	H		Summer
Wheat	Mountains	Rainfed					H	H					P	P	Winter
	Hills	Rainfed			H	H	H					P	P	P	Winter
	Terai	Rainfed**			H	H						P	P		Winter
Barley	Mountains	Rainfed				H	H						P	P	Winter
	Hills	Rainfed			H	H						P	P	P	Winter

P= Planting; TP= Trans-Planting; H= Harvesting.
* Recent option adopted by some farmers in the Eastern region, allowing two paddy crops a year.
** Supplemental irrigation is practiced in the east.

Note that the ecological zones do not fully reflect existing cropping patterns and the cropping calendar represents the most common practices within each zone. For instance, the lower parts of the Hills have similar cropping options as the adjacent Terai.

Note that for paddy, maize and millet, the crop calendar is earlier in the Eastern region by approximately one month as compared to Far- and Mid-Western regions. Therefore, for the Eastern region the earlier dates presented in the crop calendar can be utilized while for the Far- and Mid-Western regions, the later dates are accurate. Wheat and barley are not affected.

Is a response to ongoing agricultural challenges, a variety of programs have been implemented across Nepal in recent decades aimed at increasing agricultural production, especially for smallholders. The Nepal Agricultural Research Council (NARC) was created in 1991 as an autonomous research body meant to inform policy making, and to coordinate and implement research on agriculture in Nepal. The NARC currently implements more than 400

projects annually. It also partners with regional and international organizations to develop technologies and systems aimed at increasing food security and reducing poverty. Many projects focus on information diffusion, infrastructure development, and dispersion of technology, irrigation, and village savings funds. However, progress has been impeded by institutional deficiencies in oversight and innovation (Shrestha et al., 2008).

In 2007, the FAO and World Food Program engaged in a nationwide assessment to better understand the causes of chronic and transitory food insecurity in Nepal. The metrics used in that assessment included harvest indicators for year 2007 winter cereal crops, a measure of food availability, market access assessments, and national, sub-national and household-level indicators of food utilization.[6] The report highlights the importance of agricultural modernization in reducing food insecurity. As discussed above, irrigation availability is often a primary determinant of crop choice, the timing of crop planting and ultimate farming success. In the Terai, where reliable irrigation exists, three annual rice crops can be grown and harvested. Irrigation in the Hills allows for two crops of rice (summer and spring). In the Terai, maize can be harvested up to three times per year; in the Hills, two maize crops can be planted. Some early maturing maize varieties can be used in the Hills. These allow for more flexibility in crop rotation and greater cropping intensity. In addition to maize, wheat and barley can be planted between the months of October and December. Millet is planted primarily as a summer crop in the Mountains and as a relay crop in the Hills, most often following a maize harvest. In the Hills, areas that are located close to rivers and on lower slopes benefit from irrigation due to their proximity to rivers. This allows farmers to grow rice as their major crop in the summer and wheat as their winter crop. Where irrigation is available in the Hills, planting patterns are similar to those found in the Terai. However, areas in the Hills that must rely on rainwater as a source of irrigation – largely those at higher elevations – grow primarily maize. In short, cropping patterns and agricultural success in the Hills largely reflect the availability of water and irrigation resources.

Low productivity and lack of agricultural competitiveness serve to magnify Nepal's poverty and food insecurity. Rice yields in Nepal have gradually increased since the early 1990s, although the realized growth rate has been much lower than those of neighboring countries. Between 1990 and 2005, Nepal's rice yield increased by 13 percent. This compares with growth over the same period of 20 percent in India, 37 percent in Pakistan and 47 percent in Bangladesh. Based on average yields over the period 2001 to 2005, Nepal's rice yields were 7 percent below Pakistan's, 8 percent below India's, and 22 percent below Bangladesh's. Yields are highest in the Terai, making this the dominant rice-producing region of Nepal. Nevertheless, average rice yield in the Terai substantially lags those of Nepal's neighbors. In the case of maize, a comprehensive study conducted by CIMMYT concluded that, as of 2001, there had been very few improvements in yields over the previous 30 years. The authors attribute this to the expansion of maize into less suitable agroecological zones, declining soil fertility and slow adoption of improved management practices (Paudyal et al., 2001). The same authors also underscore the problems of seasonal and inter-annual variability in yields.

Many factors contribute to Nepal's low agricultural productivity, including the use of crops and livestock with inherently poor genetic characteristics, inadequate and often

[6] The remainder of this section draws from that FAO report and other sources. The full report is available at http://documents.wfp.org/stellent/groups/public/documents/ena/wfp135449.pdf.

inappropriate allocation of inputs in production, a heavy reliance on labor, tradition-bound social and economic conditions, and poor markets and marketing systems. In an attempt to address Nepal's problem of low agricultural productivity, a number of improved cereal crop varieties have been released in recent years. These offer higher yield potential, are better-suited to local growing conditions, and are in some cases more highly resistant to economically important diseases and pests. Improving rice yields has been a particularly important objective, since rice is the primary staple in Nepal, and more than 15 million hectares are allocated to rice. The NARC reports that 38 rice varieties for main season cultivation and 11 varieties for early season planting had been released as of 2007. Second to rice as a staple food is maize, of which there were 19 different varieties being grown at the time of writing (NARC 2007). Among these varieties, one maize hybrid had been released for cultivation in several agro-ecological zones. The third most important staple crop in Nepal is wheat, of which 28 varieties had been released by 2007 (mostly matched to different agroecological regions). Maize has been gaining in popularity as a major crop, as evidenced by annual increases in planted area, production and productivity. Nevertheless, maize yields remain low by most standards, with a nationwide average yield of just over 2 mt/ha.

Another drag on production is the relative scarcity of arable land. The 1992 National Sample Census of Agriculture (NSCA) reported a national average farm size of 0.9 hectares. Furthermore, land ownership is extremely skewed in Nepal. For example marginal farmers constitute 43 percent of farm households but cultivate just 11 percent of total agricultural land. Pyakuryal et al. (2005) argue that with such small and skewed landholdings, prospects for productivity growth in agriculture are bleak. Investments in agriculture and land improvements are estimated at just 3 percent of household income and current overall productivity growth in agriculture is just 0.4 percent per year.

Nepal reports low rates of use of modern inputs, in particular fertilizer. Measured in terms of available nutrient, rates of fertilizer use in Nepal are approximately 60 kg/ha compared with approximately 90 kg/ha in India. The government subsidized fertilizer purchases for many years, but subsidies were eliminated in 1999. A number of observers have argued, however, that the primary constraint to greater use of fertilizer in Nepal has not been lack of affordability, but limited supplies. Because the country does not produce fertilizers, all commercial fertilizer used in agriculture must be imported. The removal of fertilizer subsidies had two pronounced effects. First, and not surprisingly, fertilizer prices increased. This increase was seen as inevitable following the removal of subsidies. However, a second and less easily predicted outcome was that the overall supply of fertilizer increased. Although formal imports of fertilizer have fallen, informal imports from India have increased by more than enough to offset the decline (UN, 2010).

Despite the up-tick in fertilizer use in recent years, a number of issues have arisen in response to the subsidy removal. Perhaps the most important is the unreliability of the informal sector as a fertilizer source. This perceived unreliability arises due to export restrictions imposed by India, which partly have their roots in Nepal's subsidy program. Additionally, many blame informal imports for driving down prices, thereby undermining the viability and development of Nepal's private sector. Another argument regards the fertilizer provided by the informal sector to be of lower or dubious quality compared with formal channel imports. Adulteration is the typical argument. Nevertheless, even with relatively abundant supplies of fertilizer via informal channels, a routine complaint is that the rising cost of fertilizer reduces Nepal's agricultural

competitiveness, especially vis-à-vis India (Karkee, 2008). Based on the Global Competitiveness Report of 2006-2007, Nepal ranks 110 out of 125 countries in competitiveness, a fact that underscores the range of difficulties facing all sectors of the Nepalese economy, not just agriculture (Pyakuryal, 2008).

As highlighted earlier, irrigation is a key agricultural input that remains underutilized in Nepal. Irrigation is especially important for drought management, and the use of shallow tube well irrigation can in many cases allow farmers to begin planting higher-value crops such as vegetables. Many experts within Nepal argue that shallow tube wells will be essential for increasing production and enhancing food security. One benefit of shallow tube wells is that they are relatively inexpensive and therefore within the reach of poor farmers. Formerly, tube wells were subsidized by the Government of Nepal. In 2000, however, irrigation subsidies were eliminated as part of Nepal's Structural Adjustment Program (around the same time as the fertilizer subsidies were phased out). In the Terai, shallow tube wells hold much promise because the area is dry but contains substantial groundwater that can be accessed by the shallow tube wells. One recommendation has been to connect groups of tube wells to rural electricity grids to improve up-take and reduce energy costs.

While fertilizer supply and availability have improved in recent years in Nepal, the seed sector remains poorly developed. The main issue appears to be the actual quality of seeds, rather than availability. Government sources and various studies suggest that a sizeable proportion of cultivated area in Nepal is covered by improved seeds (estimates range between 80 and 90 percent for cereals and vegetables) (GON, 2006). However, because of poor seed quality, performance remains disappointing. Most farmers use seeds from their own previous harvest, or that of a neighbor. Even if these seeds come from improved strains, they rarely perform well after a few generations. The main concern is to switch the old "improved" seeds that farmers currently have with new "improved" seeds. It would be desirable to replace improved seeds at a rate of 25 percent, or every four years. Doing so would remove seeds from use before they degenerate beyond their value. The actual replacement rate is not known because of lack of statistics in seed replacement, but is thought to be about 5 percent for wheat and even lower for rice and maize. Some observers are optimistic about changes that can be brought about by simply upgrading the quality of seeds used by farmers, claiming that cereal production could be raised by 20 percent through such methods alone (GON, 2006). A two-year project under the EU Food Facility of the European Commission sought to provide vulnerable farmers with high quality seeds and other quality inputs such as fertilizer to increase food production in June of 2009. Of the 92,000 targeted households, the majority were in the mid-hills and Terai region. In assessing successes and impacts of various programs related to nutrition in Nepal, Adhikari (2011) recognized the prospect of scaling up the program in food deficit areas, in collaboration with activities currently undertaken by the WFP, FAO, and MoAC.

Unfortunately, the institutional infrastructure needed to support agriculture in Nepal is weak. While there are many rural financial institutions in Nepal, and the basic institutional structure necessary to support the expansion of agricultural credit, formal sector rural credit is severely constrained. The formal sector (those entities registered with the Central Bank of Nepal) consists of a network of commercial banks (with more than 300 rural branches), the Agricultural Development Bank (with 450 branches), and a range of various development banks, savings and credit cooperatives, and microfinance NGOs. In addition to formal lending, a large number of rural credit programs, savings and credit cooperatives, and NGOs have rural lending

as one aspect of their operation. Some NGOs remain outside of the supervision of the Central Bank; other informal lenders include community organizations, traders and moneylenders.

The forgoing discussion suggests several points of entry for public policy to promote agricultural production and food security in Nepal. How potentially valuable might be public expenditures in agriculture or in agricultural areas? There have been modest attempts to quantify the household welfare impacts of public expenditures on agriculture in Nepal. For example, Dillon et al. (2011) use hedonic estimates of plot value to measure the benefits of rural infrastructure investments. Their metrics of investment include travel time to the closest market, access to irrigation, and visits from extension services. They employ Nepal Living Standards Survey (NLSS) data from 1996 and 2004 and control for a range of fixed effects, including district level initial public investment and agroecological zones. As an alternative methodology, they also use panel data methods applied to the same dataset to measure the impact of public investment on consumption growth, agricultural incomes, and poverty status. Results show that improving access to roads is welfare-improving, leading to improvements in land values, income growth, consumption growth and poverty reduction. They report mixed, but generally positive effects of irrigation on land values, but find no measurable household welfare effect from extension services, regardless of the method they employ. This latter point emphasizes current weaknesses in Nepal's agricultural extension service, as well as the challenging environment in which it must operate.

An additional agricultural challenge of emerging importance in Nepal is the contamination of food and feed with mycotoxins. Mycotoxins are toxic secondary fungal metabolites that have significant biological effects on humans and animals when contaminated crops are consumed. Of the main classes of mycotoxins, *Aspergillus flavus* and *Aspergillus paraciticus* are the prominent producers of aflatoxins (Farombi, 2006). Aflatoxin B_1 is a natural carcinogen and the most toxic and abundant of aflatoxins (Koirala et al. 2005). The occurrence of the chemical is heavily influenced by conditions favorable to mold growth during pre- and post-harvesting processes and storage. These conditions include high temperature (36 to 38°C) and humidity (above 85%) levels (Hell & Mutegi, 2011). Dietary staples such as corn, peanuts, cassava, and rice are some of the more common agricultural commodities contaminated with the toxins, and poor processing and storage leave developing countries more vulnerable to contamination (Farombi, 2006).

The first examination of mycotoxin levels in Nepal began in 1978 as part of the Regional Monitoring of Food Contaminants Project underneath the FAO and United Nations Environmental Programme (UNEP). Food samples were taken from four countries (Nepal, India, Pakistan, and Sri Lanka) and tested for aflatoxin between 1980 and 1987 (Karki & Sinha, 1989). Results showed that corn and peanuts were the two commodities most prone to aflatoxin contamination, and the plains of the Terai provided the most favorable environment for the growth of *A. flavus* given the region's high temperatures and humidity. Karki and Sinha (1989) noted that the process by which corn was harvested (at high moisture content [18-21%] and then dried and stored without being shelled for six months) provided ample opportunity for the growth of molds. The transport of grains from the Terai region to food-deficit areas in the Hills and Mountains further provided an opportunity for aflatoxin contamination. Another 832 samples were randomly collected between 1995 and 2003 from 16 districts in eastern Nepal to test for aflatoxin by Koirala et al. (2005). High levels (greater than 30 ppb) were detected in peanuts, corn flakes, peanut butter, and vegetable oil. One-third of all samples (32.8%) were

contaminated with aflatoxin B_1 or B_2.

While corn and peanuts are two of the most commonly reported food commodities for contamination of aflatoxin, rice represents an equally important Nepalese staple food at risk for growing aflatoxin producing fungi. Lack of proper storage facilities, particularly in the storage of rice grains that must be dried in the sun during the wet season, may result in higher moisture content making the grains more prone to fungi and bacteria. A study conducted by Reddy, Reddy, and Muralidharan (2008) detected levels of *Aspergillus* species in nearly all 1,200 rice samples collected across twenty states in India. The most frequent toxin detected was *A. flavus*, the producer of aflatoxin. Degrees of contamination were heavily influenced by storage conditions and environmental factors in each state, with levels of aflatoxin B_1 most prominent where storage conditions of rice were open and exposed to rain. This finding from India suggests aflotoxin problems in rice likely extend to Nepal, although specific evidence is lacking.

Economic consequences of contamination include crop losses, reduced fertility and feed efficiency and utilization in animals, and the costs of monitoring, testing, and decontamination of the toxin (Bryden, 2007). The health and nutritional consequences, particularly in developing countries, are of even greater significance. In addition to strong evidence that aflatoxin B_1 contributes to high incidences of liver cancer (particularly in individuals with Hepatitis B or C), exposure to aflatoxin in children ages nine months to five years has been associated with stunting and being underweight (Bryden, 2007; Gong et al., 2002).

Pre-harvest strategies to reduce mycotoxin levels include the use of fungicides and insecticides, irrigation to prevent moisture stress when water is limited, and proper timing of harvesting. To protect commodities from the growth of fungus or production of toxins before or during storage, grains must be dried quickly after harvest and aerated properly, damage caused by insects must be minimized, and moisture content and temperature during storage should be regularly measured. Sodium bisulfite, ozone, and ammonia are chemical treatments that may be used to detoxify contaminated grain, and hydrated sodium calcium aluminosilicate (HSCAS) has been identified as a dietary additive that can prevent the toxin's absorption when ingested (Bryden, 2007).

A final feature of the agricultural landscape in Nepal that directly bears on food security is an on-going problem of land degradation, which, in the face of stagnant productivity growth, has become increasingly worrisome as a result of high population density relative to land mass (Hobbs, 2009). One finds large differences across regions due to differences in topology, population, geology, and existing and historical land use patterns. Desertification and deforestation have been identified as the two most pressing concerns. In the Mountain sub-regions, landslides and deforestation have been major sources of crop loss, while one third of the total area has no vegetation growth and is therefore characterized as a "cold desert." Over two thirds of the land area in Nepal is considered geologically fragile, and with high rates of soil erosion the man/land ratio continues to rise. Official reports indicate that in order to maintain a subsistence living, a family requires somewhat more than one hectare of land in the Mountain districts and half of a hectare in the Hills and Terai; currently, over half the population occupies less than half a hectare (Paudel et al., 2009). Beyond geological considerations, a third of the districts in Nepal have poor to very poor watershed conditions. Sedimentation is contributing to a rise in riverbeds which results in increased flooding (Paudel et al., 2009). Deforestation also increases time required for collection of fuel wood, which competes with other activities,

especially among women and children for whom fuel wood collection is a traditional chore.

Vulnerability, Weather Shocks and Coping Strategies

Ward and Shively (2011) use EM-DAT country-level data over the period 1980-2007 to investigate the extent to which economic development reduces both a country's disaster risk and its social vulnerability to climate-related disasters. Their analysis indicates that Nepal ranks among the top 10 countries for disaster risk, and that Nepal's predicted disaster impact (in terms of deaths per 1,000 people) is much higher than average for the country's underlying level of disaster risk. Individuals living in drought prone areas of Nepal are especially vulnerable to nutritional deficiencies. Due to isolation, this has been a long-standing problem in some locations, although Pyakuryal et al. (2005) argues that the problem has intensified in recent decades. Beginning in the 1990s, shocks to food production (including flooding, drought, and various severe weather conditions) led to annual food deficits at the national level. A 2006 winter drought resulted in nearly 900,000 households experiencing acute food and livelihood crises. A similar winter drought in 2009 led to acute and severe food insecurity among 700,000 people (above and beyond the 2.7 million Nepalese that were already chronically food insecure). Historically, floods and landslides are the most common natural disasters in Nepal, although the incidence of fires and droughts has increased. Between 2006 and 2009, extreme weather detrimentally affected food production in Nepal. The events in 2009 reduced winter crop harvests in the Mountain, Hill, and Terai regions by 40 percent, 25 percent, and 10 percent, respectively. Despite one of the largest summer crops on record, aggregate production of wheat and barley decreased by 15 and 17 percent, respectively, in 2008/09, resulting in a cereal deficit of 133,000 mt. Given that stock levels were already low from previous seasons, the isolated sub-regions in the Western Hills and Mountains were severely affected.

While isolated areas in Nepal have always been subject to severe hunger, the problem seems to have become more widespread in recent years. To deal with the adverse weather disasters listed above, and periodically high food prices, many Nepalese must resort to a range of coping mechanisms to survive. For example, in the 42 districts surveyed by the WFP, one third of households sold agricultural assets in 2008, in contrast to only one tenth in 2006; the proportion that consumed seed stock doubled from 19 to 38 percent. One in three rural families reported removing a child from school while almost 80 percent of households reported borrowing money or buying food on credit. Half of the households surveyed reported eating less (Hobbs, 2009).

To better understand the impact of extreme weather and other exogenous shocks on local food security in rural Nepal, the WFP undertook a survey focused on this issue in 2007. The survey results point out the fragility of the food security situation in much of rural Nepal; 94 percent of the households surveyed reported that adverse shocks (drought, lack of employment, illness, death, etc.) resulted in some degree of immediate food shortage. In the areas that were directly affected by drought in 2006-2007, more than 85 percent of households reported that food shortages were more severe than in the previous year; the majority had depleted their stocks of food as a response to the drought. The WFP found that household food grain stocks would be depleted in 90 days in areas that were not affected by the drought, while the corresponding figure was 15 days in drought-affected areas (FAO/WFP, 2007). Overall, a household's ability to protect itself from adverse shocks appears to be largely dependent on its socio-economic status. Poor and excluded groups found it difficult to maintain consumption relative to better-positioned

and wealthier households. Regional differences in coping also were reported. Households in the Far- and Mid-West regions were more likely to resort to irreversible and harmful coping strategies, such as selling productive assets (FAO/WFP, 2007).

The findings suggest that practically all households affected by drought shifted their consumption towards less expensive and less preferred foods. In addition, more than 75 percent of households were forced to borrow money to supplement consumption and just under this proportion reduced overall food consumption (FAO/WFP, 2007). A more dramatic impact of the drought was that nearly 37 percent of households resorted to wild food sources and almost 50 percent did not eat for at least one day. Nearly half of all households sent a family member in search of work, and 20 percent sold land (FAO/WFP, 2007).

Following the 2006-2007 drought, the largest food deficits were reported in the Central regions (281,000 tons in the Central Hills and 113,000 tons in the Central Terai). In part this reflects high rates of urbanization in these parts of the country (which includes the Kathmandu Valley). However, when examined in per capita terms, the food grain deficits were most severe in the Far-Western Hills (142 kg/person), the Far-West Mountains (143 kg/person), the Mid-Western Mountains (158 kg/person), and the Western Mountains (165 kg/person) (FAO/WFP, 2007). The only foodstuffs imported into these regions were subsidized rice provided through the Nepal Food Corporation (NFC), small amounts of international food aid, and grain brought in by migrant workers returning home. Due to the limited capacity to bring in food, local food production is considered a key factor in providing food security in these regions. Localized crop failures have the capacity to dramatically impact food availability, which could lead to acute food crises in the future (FAO/WFP, 2007).

Civil Unrest and Price Volatility

Price volatility is known to have negative consequences for grain production and the caloric intake of rural households. While weather disasters represent the largest stochastic threat to food security in Nepal, civil unrest that is manifested in blockades and general strikes (locally known as *bandhs*) disrupt food supplies and market operation, thereby resulting in food shortages and generally higher food prices. An April 2009 strike that occurred in the Terai left almost 40 percent of the markets in the Mountains and Hills with insufficient supplies of major commodities. The first six months of 2009 saw just 12 days without large-scale *bandhs* (Hobbs, 2009). So severe and ubiquitous are strikes in Nepal that the United Nations maintains a working monthly update of the distribution of *bandhs* across the country.[7]

Bandhs have been cited by 20 percent of traders as the most important factor influencing rising prices for imported commodities. The goods that are affected by *bandhs* are not limited to food and include humanitarian aid on a weekly or daily basis. Hobbs (2009) reports that, for a period of ten days in April 2009, the WFP could not distribute 3,000 mt of food in the Terai; this affected 325,000 highly food insecure households. While *bandhs* typically begin in the Terai, they can quickly produce far-reaching effects on prices and quantities throughout the country.

Working under the assumption that rural households in Nepal make production and consumption decisions recursively, Pan et al. (2009) find that the presence of price uncertainty in

[7] The list can be found on the UN website for Nepal, www.un.org.np.

production reduces the crop income of rural households at harvest time and that this lower income leads to a reduction in the caloric intake of rural households (due to the positive income elasticity of demand for calories). When demand for calories is highly price inelastic, caloric intake decisions are not strongly affected by changes in the prices of staple foods. From this it can be argued that the caloric intake of rural households in Nepal is determined largely by income not prices. In part this reflects the subsistence orientation of many rural farm households. If much of staple crop consumption comes from own production, response to price signals will be weak. In addition, those farmers that participate in the market tend to sell their output at harvest, rather than store the crop for later sale (at presumably higher prices). This pattern reflects high on-farm storage losses, indebtedness, and cash needs to meet family and social obligations. These factors all contribute to explaining the stylized empirical fact that rural farm households in Nepal are not very responsive to price changes (Pan et al., 2009).

With this in mind, Pyakuryal et al. (2005) argue that medium run development policy in Nepal should focus on the storage and marketing of crops by private enterprises. Plausible incentives to facilitate this include development of transportation and storage facilities. A large proportion of government subsidies has been directed towards planting grains due to the adverse geography of the country. This includes air transport for shipping grains. Pyakuryal et al. (2005) argue that a transition to ground transportation will improve food security. Long run goals might therefore include integrating markets through road networks, infrastructure and marketing.

Society, Gender and Nutrition

In one of multiple studies of factors correlated with malnutrition in Nepal, Pant (2008) argues that malnutrition does not necessarily result from a lack of food production, but rather is caused by a range of social problems and the inherently low status of women in Nepalese society. In many instances, the effects of social indicators can actually be attributed to group norms because ethnic groups in Nepal have strong influence on labor supply, family planning decisions and the timing of births (Thapa, 1989). Using data from the 1996 Nepal Living Standards Survey, Nyyssöla (2007) finds a relationship between mother's status and her children's food security, showing that an increase in childbearing age and mother's education lead to higher z-scores among children.

Mother's education is a key determinant of nutritional outcomes at the household level, since a primary cause of malnutrition is simply a lack of knowledge regarding the factors that contribute to improved health and nutrition (Marmot, 2007). NDHS data from 2006 show that children of uneducated mothers are more likely to be underweight than their cohorts, and that this pattern holds across wealth quintiles (UNICEF, 2010). This suggests nutrition education interventions may be necessary at all levels of wealth, not just for the poorest families. Moreover, a correlation between mother's education and nutritional status exists for multiple deprivation outcomes. The largest marginal impacts of improvements in education are likely to be found in the Mountain regions, where malnutrition rates are one-third lower for women with primary education than for those with no education. The NDHS data indicate that fewer than half of all Nepalese women are literate, which creates a large impediment to improving child health and nutrition outcomes (UNICEF, 2010). In Nepal, many parents are reluctant to invest in education for their daughters beyond fifth grade, since this requires a family to offer a larger dowry to attract a husband of similar or higher educational stature (Sah, 2005).

Agriculture in Nepal is increasingly an activity of female members of the household as more men migrate and enter the non-farm sector. This change has been accompanied by a change in the structure of incomes for rural families, in which farm income has declined as a result of lower productivity and non-farm sources have increased in importance. These forces have led to a relative decline in women's incomes compared to men's. Because female literacy is less than 35 percent and girls tend to drop out of school before boys, they have lower productivity and have heavier workloads, high risk of pregnancy, poor nutrition, and worse health. Men generally have authority over family planning and financial issues, and even in the case where women have autonomy in the household, they are constrained in many cases by community considerations (Sah, 2005).

In a study of the determinants of child nutrition in the Terai, Sah (2005) found that social factors were significant in explaining observed levels of underweight and stunting in children. Data were drawn from a post-intervention evaluation of a child nutrition program in Dhanusha in 2003. The outcomes of interest were stunting, measured as height-for-age, and underweight, measured as weight-for-height. Bivariate correlations revealed a strong relationship between the nutritional status of children under 36 months of age and three factors: mothers' education, the use of rice scum, and age. The use of colostrom was a strong predictor of underweight but was not correlated with height-for-age at statistically significant levels. However, indicators of households' sanitary behaviors were positively correlated with nutritional indicators.

Sah used regression analysis to demonstrate differences in nutritional status across age groups, where older children were more likely to be underweight than children under 6 months of age. Among children six months of age or younger, only a small proportion were found to be underweight, but the proportion increased markedly at age groups of 7-12 months and beyond. Among household socioeconomic indicators, being a member of a minority group increased the probability of a child being both stunted and underweight. The most pronounced differences were related to the literacy of the mother, rather than economic well-being. Sah did not find gender differences in child outcomes.

Among the attributes associated with feeding practices and health, the intake of colostrum has been found to have a measured effect on underweight. Also, households that reported utilizing rice scum had a reduced propensity of both underweight and stunting. Finally, washing hands prior to feeding reduced stunting. In line with other studies, Sah's research suggests that beginning supplementary feeding six months after birth is beneficial to a child's nutritional status, because mother's milk provides insufficient nutrition beyond this age. For Sah's sample of children in the Terai, late initiation of supplementary feeding was correlated with increased probability of a child being underweight. Sah argues that the results reflect social taboos of two forms – those that prohibit women from consuming nutritious foods during pregnancy and childbirth, and those that prevent them from receiving proper medical attention during pregnancy and childbirth. His main conclusion is that supplementary feeding at appropriate ages combined with attention to maternal care are the pathways with greatest potential to reduce child malnutrition.

Gittelsohn et al. (1997) used dietary journals, comprised of both food intake recall and direct observation of meals, to show that despite variation in the application of cultural norms related to food consumption, dietary prescriptions do have a direct impact on food consumption behavior. They found a positive relationship between the amount of calories consumed and the

intake of various micronutrients for the whole population, but no robust pattern across particular subpopulations, including adult women and adolescent girls. These groups are at risk for diet deficiencies in vitamins A and C, especially in rural areas in Nepal. The authors found that food beliefs and practices resulted in subgroups being at risk for nutritional deficiencies, which may explain the low correlation between micronutrient intake and energy intake. Gender differences in access to particular foods were found to be associated with specific food beliefs and practices, resulting in the reduction of women's consumption of foods rich with micronutrients. Practices include dietary restrictions during menstruation, pregnancy, and lactation. Compounding these particular practices is a general discrimination in favor of men for intrahousehold allocation of food. The authors argue that staple foods, such as rice, lentils, bread, and soup, are fairly evenly distributed across gender lines, but that side dishes rich in micronutrients, such as vegetables, yogurt, ghee, and meat, are allocated preferentially to small children and adult males.

Using data from the Nepal Demographic and Health Survey (2006), Dancer and Rammohan (2009) show that mother's education has a large positive influence on the nutrition of all children, particularly girls. They find that primary education has very little impact on the height-for-age measure of male children; however, there are substantial improvements on the height-for-age z-scores across the whole sample when the mother receives a secondary education (compared to no schooling). Children with mothers who had received education through primary school were found to be less stunted. The effects of secondary schooling on stunting were dramatic for both sexes, but the effect was largest for female children: those with a mother who had a secondary education were half as likely to be stunted as those with uneducated mothers. For males, the corresponding odds of not being stunted were 1.45 times greater. While the mother's education had an impact on child development, a father's education did not correlate with stunting. When a woman had more autonomy in decision making, there were much higher odds of her child not being stunted.

Pokhrel et al. (2005), using 1999 NLSS data, reports evidence of gender bias in the reporting of illness, and that the bias grows following the initial decision to seek medical care. A cultural explanation is put forth, based on the observation that many people in Nepal have a strong 'son-preference'. Considering health care as an investment, some families may not capture the rewards of an investment in a girl if she subsequently marries and leaves the family. However, the magnitude of this gap in the predicted probability of reporting an illness is relatively constant across income, suggesting that gender discrimination does not result wholly from economic hardship.

An additional finding is that child gender not only influences whether a family utilizes health care, but also impacts multiple decisions regarding health actions. In addition to influencing the decision to report an illness and then to subsequently seek care, child gender has also been found to influence whether one chooses a public health care provider, compared with seeking no care or using informal sources. As might be expected given the previous finding, expenditures on private care favor male children, a finding that has also been observed in Kerala state in India, where gender was not associated with whether the child was treated but did play a role in the selection into allopathic treatment versus alternative treatments.

In an effort to determine whether small increases in female income have a significant effect on family welfare, health, and nutrition, Katz et al. (2001) conducted a nonrandomized controlled experiment to measure the impact of small amounts of income (delivered to female

members of a household) on food expenditures and the nutritional status of women. Women in the study were part-time workers in a health project. Because they were screened for employment, those that were hired tended to be younger and better educated than women not employed, but similar in other respects. Baseline comparisons between the groups showed that the women were similar in caste, household size, ownership of animals and household durables. Additionally, the mid upper-arm circumference (MUAC) across the groups had a difference of just .2 cm, and food consumption expenditures—after controlling for baseline characteristics—were also comparable. Follow-up surveys taken after two years showed no differences in MUAC between the two groups. However, women in the "employed" category consumed ghee, meat, eggs, fish, and vegetables at higher rates. Over the survey period, consumption of higher valued products decreased across both groups, but households with employed women maintained relatively higher levels of consumption of these products.

Finally, in another analysis of household food security in rural Nepal, Gittelsohn et al. (1998) used a principal-factor method to operationalize the construction of household food security. Household food security was conceived of as being made up of three components: past food stability, current food supply, and future productivity. The results of the analysis indicated that high caste and socioeconomic status had positive correlations with the consumption of green vegetables, tubers, and dairy products. Current food stocks, as well as a measure of future agricultural productivity, were found to be useful predictors of dietary variety and consumption of dairy and meats. The results suggest that household food security in the sample had no significant relationship with consumption of grain and beans, as they are considered staple foods. However, the measures did seem to impact dietary diversity, in the form of leafy vegetables, dairy, and meats. Household caste and socioeconomic status had similar impacts. Generally, the study represents an attempt to create a formal framework for analyzing food security at the household level by taking into account multiple dimensions of food security across time.

Impact Assessment of Nutrition Interventions

A growing body of research seeks to report on the efficacy of nutrition interventions in Nepal. Pant et al. (1996) report results from a randomized controlled experiment that was undertaken in seven districts of the Terai and Mid-Hill areas of Nepal. They evaluated the performance of two programs designed to improve vitamin A status. The two programs focused on supplementation and education. The education component included horticultural and public health activities. The authors argue that although nutrition education has been promoted as one of the best ways to improve the nutritional status of at-risk individuals and populations, education programs can be difficult to implement. Their argument is that nutrition education programs to address vitamin A deficiency will have very small impacts unless education is combined with personnel, finances, and equipment.

The program implemented by Pant et al. (1996) used two criteria to compare outomes: (1) the cost for the overall project (which was extrapolated to assess different levels of program intensity), and (2) the project's impact on individual health status (primarily xerophthalmia and wasting). To measure outcomes of the interventions, they also included as a metric of performance total coverage, as a way to judge any potential spillover effect that may arise in a traditional supplementation program. Two sample populations were studied to measure the impact of the two programs. Cohorts were followed for 24 months after program implementation in order to capture short-run, medium-term, and longer-run effects on vitamin A deficiency

status. Results revealed a consistent pattern in which socioeconomic and ecological problems explained a large amount of the variation in vitamin A levels, vitamin A deficiency risk, wasting, and excessive mortality. Both nutrition education and supplementation were found to be effective in reducing risks among children; however, neither program had a significant influence over whether the community could be considered a "high-risk cluster site." They conclude that improving economic opportunities, sanitary conditions, and agricultural productivity are essential to minimizing the impacts of vitamin A deficiency. However, the authors also conclude that distributing mega-dose capsules on a semiannual basis, boosting vegetable consumption, and improving access to primary health care services should be policy initiatives in the short term. When considering the implementation of a supplementation program in Nepal, their analysis points out that decisions regarding program choice may be influenced more by the relative costs of the program than by differences in program outcomes. Their results show that education and supplementation had comparable effects, although the overall coverage rate of the supplementation program exceeded that of the education program. The primary benefit they observe in controlling vitamin A deficiency is a reduction in mortality. Mortality risk was reduced by a somewhat greater amount among the supplementation cohorts, although specific aspects of their nutrition education and maternal literacy programs were more effective in reducing mortality than supplementation alone.

Overall, results of Pant et al.'s study suggest that nutrition education in Nepal can be just as effective as direct supplementation. However, where maternal literacy rates are low and pathways for communicating public health and nutrition messages are weak or non-existent, achieving the same level of effect may be more costly for education than for capsule-based supplementation. They observe that policy-makers in Nepal have been reluctant to use nutrition education programs to address vitamin A deficiency because education has been viewed as less effective than supplementation. Their findings show that nutrition education may be less cost-effective than supplementation not because it is less effective, but because it tends to be more costly.

A different randomized control trial was undertaken by Christian et al. (2003) to study the effects of different combinations of micronutrients on birth size and risk of low birth weight. They found that providing mothers with supplemental folic acid (alone) did not influence child size at birth. However, combining the folic acid supplement with iron increased mean birth weight by 37 g (the 95% confidence interval was -16 g to 90 g). This combination also reduced the percentage of low birth weight babies (those below <2500 g) from 43 percent to 34 percent. Supplementation with multiple micronutrients increased birth weight by 64 g (95% confidence interval 12 g to 115 g) and reduced low weight births by 14 percent. The incidence of pre-term births was not correlated with any of the supplement combinations. Folic acid combined with iron and multiple micronutrients increased the head and chest circumference of newborns, but not their length.

Using randomized controlled trials, again in rural Nepal, Manandhar et al. (2004) found that the utilization of women's groups that were headed by local female facilitators reduced neonatal mortality by 30 percent. In addition to reductions in neonatal mortality, maternal mortality was also observed to be lower in the study areas, although this was not one of the outcomes of interest in the study. The presence of a local facilitator promoted home care and health care seeking practices for the prevention of maternal and neonatal morbidity. In quantitative terms, they found that one facilitator assigned to a population of 7,000 could interact

with a large proportion of pregnant women in that population, including women in remote and poor villages. Despite the fact that only 8 percent of married women of reproductive age participated in a group, more than 37 percent of newly pregnant women were reached. Group members increased awareness of health knowledge regarding perinatal issues and spread knowledge beyond the treatment group. As part of the study, the authors undertook a cost effectiveness analysis. They report that the cost per newborn life saved was approximately $3442 and the cost per life-year saved was $111. The World Bank has recommended that, on cost-effectiveness grounds, interventions that cost less than $127 per disability-adjusted life-year saved should be considered. This program satisfies this requirement. Furthermore, beyond the program benefits quantified in the study, the authors suggest the program also provided long-term benefits for subsequent pregnancies, reductions in morbidity, and potential cost savings in setting up and supervising future projects.

Projects Underway

Due to the numerous food security challenges Nepal faces, it has been selected as one of twenty countries to benefit from the U.S. Feed the Future (FtF) Presidential Initiative. As part of the program, 16 districts of the Western Terai and Hill regions of Nepal have been chosen as program beneficiaries.[8] The US$68 million program for Nepal, which is planned to run from 2011-2015, calls for a multi-sector approach to increase agricultural productivity, raise income, increase nutrition, and stem chronic food insecurity in the targeted regions. The three focii of the program are (1) nutrition and hygiene, (2) high-value agricultural production, and (3) integration of vulnerable groups.

With respect to agricultural productivity, the United States Agency for International Development (USAID) plans to introduce yield-enhancing high value crops and technologies, improve technical support for farmers, expand access to irrigation, and improve small-scale market infrastructure. For nutritional outcomes, the plan focuses on increasing production of high nutrition foods, training and employing thousands of community facilitators and nutrition hygiene volunteers, and increasing access to safe drinking water. Finally, to address inequalities in access and education for particular groups (women, children, minorities), the plan seeks to provide literacy, nutrition and entrepreneurial skills training, to encourage female-friendly farming practices, and to target all family members with education intended to shape and change behaviors.

In addition to the massive FtF program, USAID has over a dozen programs running throughout the country with a focus on health, nutrition, growth, education, or food security. USAID is one of the largest health donors in Nepal, with annual investments in 2010 of over US$26 million towards the development of equitable and well-governed health systems with the goal of reducing mortality among women and children and improving access to health services.

Since 1963, the World Food Program has carried out 51 projects and programs for an increasing number of food insecure populations in Nepal (Frankenberger et al., 2010). Many food aid operations are geographically concentrated in food-deficit areas in the Hills and Mountains of the Far- and Mid-Western Nepal, where poor infrastructure is a major obstruction

[8] These districts are Baitadi, Dadeldhura, Kanchanpur, Doti, Kailali, Achham, Dailekh, Jajarkot, Rukum, Surkhet, Salyan, Rolpa, Phuthan, Banke, Bardiya and Dang.

to the distribution of food from surplus areas to markets. As noted by Codling (2011), many aspects of food insecurity relate to access issues and poverty. Poverty is concentrated in the agricultural sector which makes up 70% of Nepal's workforce (Codling, 2011). Inadequate roads and markets coupled with low agricultural productivity make it difficult to produce sufficient income. As a result, households must depend directly on production for their food.

Current WFP operations include Food and Cash for Assets (F/CFA), micronutrient supplementation interventions for children, school feeding programs, girl's incentive program (GIP), Mother and Child Health Care (MCHC), and food assistance for Bhutanese refugees. Food and Cash for Assets programs are among the most widely implemented, comprising 38% of total operations between 2002 and 2009, and 1.6 million were targeted for the program in 2010 (Frankenberger et al., 2010). Through these programs, participants work on community infrastructure projects such as building and repairing roads and building irrigation systems. While WFP assessments found that these programs were able to positively impact immediate income and food needs, the programs were less affective at improving livelihoods in the long run through the restoration of key assets (Frankenberger et al., 2010).

Decreases in funding related to the global financial crisis have forced the WFP to dramatically scale back operations in some of the most food insecure areas in western Nepal. The WFP has recognized its limits in addressing long term food security in comparison with short-term needs, and acknowledged that the government must step in to lead development projects to address chronic food insecurity in the region. In a 2009 nutrition assessment and gap analysis report, Pokharel et al. (2009) suggest that the GoN integrate policies related to poverty with nutrition intervention programs to prevent future emergency crises. Establishing a formal and institutionalized approach, or "nutrition architecture," to guide coordination across sectors may help to ensure that previous program failures are not repeated.

Appendix: Data Availability

Two large country-wide datasets available for Nepal are the Demographic and Health Surveys (DHS) and the Nepal Living Standards Surveys (NLSS). DHS survey data are available for 2001 and for the most recent round, conducted in 2006. Both are geo-referenced and are publicly available. A current round of the survey is being collected at the time of writing, and will likely be made public in the next 12-18 months (by early 2013). The 2006 sample includes 10,793 women and 4,397 men between the ages of 15 and 59. Characteristics of the sample include data covering abortion history, anemia and anemia testing, anthropometry, birth registration, cause of death, early childhood education, HIV knowledge and testing, malaria, micronutrient intakes, reproductive calendar, TB, tobacco use, vitamin A, and maternal mortality.

The NLSS datasets were collected in 1996 and 2003/2004 and include a partial panel data component. A third NLSS dataset was collected in 2010/2011 and preliminary findings were provided by the Central Bureau of Statistics of Nepal in August of this year; however, a full statistical report has yet to be released. The NLSS includes information on a range of household welfare indicators, including income, consumption, housing, labor market participation, education and health). Second round data are similar in content and coverage to first round data. The NLSS survey follows the approach of the World Bank's Living Standards Measurement Study (LSMS). The survey consists of an integrated household questionnaire supported by a community questionnaire to collect information on available facilities, service delivery, prices and general conditions facing households. The survey includes a module focused specifically on health, and includes a number of ancillary questions. These questions include distance to health facilities (mode of transport and time) and expenditures on health services (during the past month and year). The health module contains information on chronic illnesses and recent illnesses, including length of affliction, amount of treatment time incapacitated, and current self-reported health status. Immunization information is collected for children under 5, along with maternity information and family planning information. Subjective questions include how the family rates the quality of their health services. Food consumption data are based on variable period recall. Questions cover whether a particular food was consumed over the past year, how much was grown and consumed, how much was typically consumed per month (by weight), food expenditures for typical month, and the amount of food received in-kind. The list of foods is typical of an LSMS survey and does not vary by quality. Additional information includes household production, wage employment, education, credit and savings, household business activity, remittances, and other sources of income.

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