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PREFACE

We are happy to bring out the present volume of Nepalese Journal of Agricultural Economics (NJAE) with growth and equity as the dominant theme and incorporating issues such as the MDG and post-2015 development agenda of prosperity for the deprived people and their food and nutrition security, strategic process models, fiscal policy, climate change resilience, hydrologic institutions, farm production efficiency, agro-processing industry, and agricultural statistics systems on which authors from across Asia, Europe and North America from diverse backgrounds and experience contribute.

Almost by definition, the development of agricultural economics in the high altitude systems such as Nepal and neighbouring regions incorporates the agricultural and food systems in the Himalayan-Hindu Kush region, symbolized by this journal's cover page by the picture of Sagarmatha/Chomolungma/Mt. Everest as it is variously referred and Nepali Yak (or Yeti?). In that sense, the journal accords a high priority to high altitude agriculture and food systems and its interactions with the neighbouring economies and societies.

NJAE thus intends to serve as a common academic, research and development forum from thinkers in agriculture, forestry, fisheries, and allied economic activities in industry, trade and finance from the point of view of economics, sociology and anthropology, environmental science, natural resource management, law and institutions and inter-disciplinary synthesis, as a process of research-policy-development dialogue to expedite the modernisation of agriculture and agrarian transformation by bringing together the wisdom, experiences and feedbacks from our fellow professional colleagues and other contributors.

My sincere appreciation goes to the international panel of editors Prof. Prashotam Dass, University of Manitoba, Canada, Dr. Ramesh Chand, Director of National Centre for Agricultural Economics and Policy Research, India, Prof. Saleim Rahan, Dhaka University, Bangladesh, and University of Manchester, UK, Prof. Wen-Chi Huang, National Pingtung University of Science and Technology, Taiwan, and my colleagues from Nepal Dr. Ganesh Raj Joshi, former secretary in the Ministries of Agriculture, and Forestry, Dr. Kamal Raj Poudyal, Economist, PACT, Ministry of Agriculture, Dr. Krishna P Pant, Visiting Faculty, Kathmandu University, and Fellow, SANDEE, Dr. Sridhar Thapa, Economist, World Food Programme, for putting their efforts to bring out the journal, and to Dr. Kailash Pyakurel, Vice-Chancellor, Agriculture and Forestry University, and Mr. Anand Aditya, President, Chelsea College for his editorial inputs, and Mr. Rudra Shrestha, former director for Publication, Information and Public Relations, NAES for co-ordination and reviews. I thank the authors, members in the anonymous review panel, institutions, NAES members and other participants in the generally assembly and others whose help was essential in bringing out the journal papers in the present form.

We look forward to comments and suggestions from colleagues and fellow professionals.

September 1, 2014

Dr Y B Thapa
President
EDITORIAL

The Nepalese Journal of Agricultural Economics publishes high quality peer reviewed research articles with high potentials of contributing policy reforms in agricultural sector in Asia. The papers published in this journal are expected to help practitioners, policy makers and researchers in the continent and beyond.

The papers in this volume cover very pertinent themes such as the contribution of agricultural growth strategies to the MDGs, strategic process models for sustainable development, fiscal policy, climate change effects and adaptations, water resources development with hydrologic institutions, production efficiency, food and nutrition security with diversified diets, agro-processing industry, and validation of agricultural statistics. These articles draw from developments in many countries such as Nepal, Bangladesh, Cambodia, Laos, and China and we further hope that the recommendations put forth here would be of interest to the readers and agricultural development practitioners in many more countries.

On the overarching socio-economic issues, the paper 'Is Agriculture Central to Achieving the Millennium Development Goal of Halving Poverty By 2015 in Nepal?' shows that in Bangladesh, Nepal, Cambodia and Lao PDR, the prospects of achieving MDG at US$1.25 or $2/day are bleak if historical trends in drivers of agricultural growth continue; note that even if the MDGs were to be fulfilled by 2015, these have addressed only half of the problem and have been leaving the remaining issues for the post-2015 development agenda. The low-income countries with weak governance or institutional quality or with low ease of doing business would need larger increases in agricultural ODA, expenditure or investment to achieve MDG1 at both US$2 and $1.25 per day. These results raise two policy dilemmas: one is the trade-off between real resource transfer to agriculture and institutional reform, and the other is a similar trade-off between resource transfers and business environment. The resource requirement for accelerated agricultural growth and institutional reforms forms the basis of a comprehensive and workable policy agenda.

The paper 'Strategic Process Models for Sustainability' shows that strategic management helps deal with “messy” problems by integrating multiple, even conflicting, factors through models of strategic processes, namely, guided evolution, learning and competencies, institutional and structuration, complexity, and critical and postmodern approaches. These strategic process models can be further integrated for developing actionable knowledge and knowledgeable practice of sustainable management in organizations in the future.

The paper 'Nepal: A Fifteen-Year Agriculture Tax Policy Perspectives 2015-2030' dwells on the anomaly that despite government campaigns for commercialization of agriculture in Budget and Plan Documents, the social laws promote fragmentation of holdings detrimental to implement large-scale farming and make it difficult to move towards Green Revolution through mechanization. Thus, there is need for reforms in agriculture sector in phases namely Transition Phase 2015-20; Phase of Consolidation 2020-25; and Phase of Expansion 2025-30. These
phases with adjustments in Acts and Regulations would enable agriculture sector to improve its productivity and implement commercialization through agro-enterprises.

On climate change issues, the paper 'Impact of Climate Change on Agricultural Production in Nepal' concludes that the impact of precipitation and temperature on farm revenues seems to be varied in different climatic zones, crop calendars and socio-economic variables; in the latter case, small farms manage better and obtain higher net income per hectare than large farms. Further study may be carried out using agronomic-economic and CGE models.

The paper 'Crop Yield Responses to Climate Change in the Tropical Region of Nepal' considered crop yields of paddy, maize, wheat, and potato as dependant on rainfall, maximum/minimum temperature, and concluded that climate variables and their deviations within the growing seasons are the important determinants of crop yield. The effects of climate variables on crop yield depend on crop types, growing seasons, and locations. Another case study entitled 'Climatic Variability, Rice-Based Cropping Systems and Impacts on Livelihoods: a Comparative Study of Chitwan and Kavre Districts, Nepal' suggests that rice production has not been affected severely by the effects of climate change so far, but adaptation measures are required to remain safe in future.

These issues of climate change lead to water management and related institutions for efficiency and equity. So the paper 'Inequity in Water Distribution due to Social Heterogeneity' test the idea that the Farmer Managed Irrigation System (FMIS) in Nepal, while more efficient and sustainable than other systems of irrigation, face problem when the society is heterogeneous resulting in inequity in water allocation and cost recovery and thus lead to the market failure. Upper class dominates on the water rights using it first, and plant high value crops. They release excess water for use by the lower class and compel to grow not only less remunerative crops but also pay higher cost per unit of water. Gross inequity in water distribution means a large proportion of fallow and abandoned land among the peasant class. Thus government interventions are called for improving the situation.

On the other hand, the study 'South-South Cooperation - the Case of Farmers' Water User Associations for Rural Reform in China' contributed to the rural reform strategies for more equitable, efficient, and peaceful water use. This strategy not only helped to democratize farmers' participation in irrigation management but also based the farmers' water user associations on hydrologic boundary in the Jingmen city, Hubei Province, Yangtze River Water Resources Development Project. The institutional reform in the local irrigation management produced benefits in terms of ownership, reduction in water-related conflicts, reliable and equitable irrigation deliveries, increased agricultural productivity, and more effective use of local government resources. The WUAs enabled farmers to cooperatively manage emerging challenges and concerns related to the irrigated agriculture.

In the same vein, a review of the book 'Pokari ra Pahiro' (Ponds and Landslides) concerning watershed management in the mid-hills of Nepal presents ways of managing natural resources by reviving the traditional system of water management in the hills for ensuring the
food security and adapting to the problems of the extreme events caused by the emerging climate change. Thus the environmental problems associated with agriculture and food security as well as the emerging challenge of impact of climate change can be minimized with water-centric resource management in the highlands in Nepal and beyond.

On food security aspects, the article 'Resource Use Efficiency in Vegetable Production in the High Hills of Eastern Nepal' finds that the mean technical efficiency score was 0.79 indicating high potential in increasing vegetable production; one would recommend the policies of focusing on improving land, developing skilful labour, encouraging vegetable farmers to promote compost, easy access to farm capital, fertilizers and pesticides. Additional policies include innovating and adopting improved seed varieties, easy access to credit facilities, and technical supports and backstopping to farmers, and encouraging women farmers in vegetable production.

The article 'Horticulture in the Food and Nutrition System of Nepalese Economy' emphasizes increased production, productivity and consumption of nutritious fruits, vegetables and spices. So it elaborates an improved technology transfer through demand-based horticulture extension service delivery where the major components include: improving year-round home-gardens for nutrition; and commercialization of fruits, vegetables, and spices for cash income through improved technology and marketing system. Similarly, the article 'Food and Nutrition Security in Nepal - a Review of the Policies and Strategies in the Forestry Sector' shows the major areas of forestry sector contribution in food security as: livelihood improvement program of leasehold forestry for the groups of poor households to grow short-term and long-term crops; livelihood improvement programs including land allocation to poor households in community; and harvesting and selling of non-timber forest products and/or medicinal aromatic plants (NTFPs/MAPs) in community and leasehold forests for sale to traders. One can find several models for community based development and agro-forestry processing, and support symbiotic relationships between the indigenous community and pristine ecosystems.

On the gender dimension of food security, the article 'Women’s Empowerment and Farm Productivity - a Case of Project Intervention' examine food insecurity as more chronic with women because of deeply rooted unequal distribution practices prevalent in traditional rural communities. Women’s participation in skill trainings, off-farm jobs and project activities contributed to their empowerment and, thus the wage parity. Women’s participation in capacity building, natural resource management and institutional development enhance their economic potential through higher productivity in farming.

On the promotion of agri-business, the article 'Effects of Taxing on Bribeing in Agro-Processing Enterprises in Nepal' shows that taxes, fees, and fixed costs are among the major factors inducing temptation in paying bribes by agri-business establishments, and such results can help in developing targeted policy measures in controlling corruption. Finally, the article 'Estimation of the Agricultural Statistics of Nepal' shows that if the implementing agencies are given authority to measure output it can lead to biased estimates of the outcomes; so one need
to apply scientific tools in crop modelling and monitoring, using remote sensing and giving authority to an independent agency such as an independent Central Bureau of Statistics (CBS) for the generation of statistical data. The Journal also lists some important areas that the forthcoming issue would address; we welcome and look forward to appraisals and support in our endeavour.
Is Agriculture Central to Achieving the Millennium Development Goal of Halving Poverty by 2015 in Nepal?

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Abstract\textsuperscript{1}

Whether accelerated growth of agriculture – through agricultural expenditure, official development assistance (ODA) or investment – makes a difference in the prospects of achieving the Millennium Development Goal of halving poverty by 2015 (MDG1) in selected low income countries (Bangladesh, Nepal, Cambodia, and Lao PDR) in Asia and the Pacific region is analysed. The prospects of achieving MDG1 ($2/day) are bleak if historical trends in drivers of agricultural growth continue over the period 2007-2013. The prospects are slightly less bleak if the lower poverty line of $1.25/ day is used, in so far as Bangladesh is on track but not the remaining three countries. Our analysis confirms robustly that increases in agricultural ODA, agricultural expenditure, fertilizer use or agricultural investment would accelerate agricultural and gross domestic product (GDP) growth and, consequently, improve the prospects of achieving the more ambitious MDG1 (US$2 per day). Classification of individual countries into various categories reveals that low-income countries (all four countries studied are included) with weak governance or institutional quality (all four included with some variation), or with low ease of doing business (all four included with some variation), would need larger increases in agricultural ODA, expenditure or investment to achieve MDG1 at both US$2 and US$1.25 per day. These results raise two related but distinct policy dilemmas: one is the trade-off between real resource transfer to agriculture and institutional reform, and the other is a similar trade-off between resource transfers and the business environment. While the challenge of reducing the scourge of poverty is daunting, the resource requirements for accelerated agricultural growth and institutional reforms delineated here could be the basis of a comprehensive and workable policy agenda.

Key Words: Millennium Development Goal (MDG), Agriculture, Investment, Institutions, Nepal

\textsuperscript{1} This paper draws upon two recent studies, IFAD (2011) and Imai et al. 2011. We are grateful to Nidhi Kaicker and Y. B. Thapa for valuable assistance. The views expressed are personal and not necessarily of the institutions to which the authors are affiliated.
1. Context

Poverty is primarily a rural problem in Asia and the Pacific Region (APR). About seventy percent of poor people in the world live in rural areas and depend on agriculture for their livelihood. Half of all rural poor live in South Asia (490 million) where the absolute number of rural poor has increased despite a decline in the incidence of poverty. More recently, the poor have borne the brunt of the three F (food, fuel, and financial) crises, which has made meeting the Millennium Development Goal of halving poverty by 2015 or MDG 1 (i.e. halving extreme poverty by 2015) a greater challenge for governments in Asia and the Pacific Region. They grapple with the problem of achieving sustainable growth while simultaneously reducing rural poverty.

It is essential to distinguish between transient poverty and chronic poverty. Failure to distinguish between the two may result in directing resources (under the poverty reduction programs) to those households who are only temporarily poor (error of inclusion) and leaving out those who are actually poor but may temporarily be out of poverty (error of exclusion). The ‘chronically poor’ have few assets, little or no political voice and are usually based in remote locations with poor or non-existent public services, high levels of violence, and desperate living conditions. They are victims of social discrimination based on caste, gender, religion, ethnic identity, age and other factors. They have limited work opportunities, which allow only day-to-day survival. Poor households are handicapped by low income, lack of education, assets and limited opportunities for economic advancement. Rural poverty is a multidimensional phenomenon, which includes along with income, other intrinsically important dimensions such as lack of education and assets, and limited opportunities for economic advancement, among others.

Rural women, youth, and indigenous peoples experience such disadvantages disproportionately, making it harder for them to exit poverty. Women, particularly in developing countries, are more likely to be engaged in the informal sector, which offers low wages, no formal social protection, and limited opportunity to gain skills. Disparities continue to exist between men and women in the workplace and in wages. Controlling for occupational differences, women on average earn around 50 percent of what men earn in South Asian countries. Similarly, Asia and the Pacific Region youth (who constitute 61.5 percent of the 1 billion worldwide) live predominantly in rural areas, and require assistance to escape poverty and lead better and more fulfilling lives. Many children (0-14 years) and youth (15-24 years) are unable to reach their potential because of poverty, hunger, poor health, and lack of education and skills. Poverty encourages child labor, which is common in developing countries. Of the 900 million poorest of the poor people in the world, at least one third are indigenous peoples and more than half live in Asia and the Pacific Region. Most of them are socially, politically, and economically marginalized, endangering their survival in a rapidly changing environment.

Poverty is not just a matter of deprivation but also of vulnerability to exogenous shocks. Shocks can trap people in poverty by eroding their assets and capabilities to a point that they are unable to accumulate enough to move out of poverty. The shocks may be linked to climate change, pest
outbreaks such as avian influenza, food price fluctuations, illness, and death. Rural communities and households have a range of mechanisms for coping with downturns. As risk-coping mechanisms, households often resort to selling productive assets, borrowing, depleting savings, migrating, and reducing expenditure on food, healthcare and education (notably affecting women and children). Although they have developed relatively strong risk-management and risk-coping strategies, vulnerability remains high. Asia and the Pacific Region is also highly vulnerable to fluctuations in energy markets due to its high dependence on fossil fuels. This has considerable impact in terms of vulnerability to food insecurity. Some parts of the region (e.g. Afghanistan, Sri Lanka, Nepal, Indonesia, the Philippines, and Pakistan) are also affected by instability and conflict, or have recently recovered from conflict.

2. Objective

The objective of the present study is to analyse the role of agriculture in achieving MDG1 halving of extreme poverty (estimated at the poverty cut-off point of $1.25) and moderate poverty estimated at the higher cut-off of $2 per capita by 2015, relative to the level in 1990 in selected low income countries in the APR with a focus on Nepal\(^2\). In this analysis, we will first estimate the likely contribution of agriculture to GDP growth and its implications for both extreme and moderate poverty. The next step is to assess the prospects of poverty reduction through extrapolations of historical trends in various drivers of agricultural growth: agricultural expenditure, investment, and ODA in agriculture. If the likely or expected poverty reduction falls short of the desired, counterfactual simulations are carried out to illustrate required ranges of increases in these variables. Attention will be drawn to improvements in institutional quality to accelerate growth and poverty reduction. Questions relating to policy dilemmas arising from trade-offs between resource transfers and improvements in institutional quality will also be addressed.

After providing context and objectives of the study, Section 3 is devoted to salient features of the Nepalese economy in the context of other low income countries such as Bangladesh, Lao PDR and Cambodia. This is followed by a discussion of poverty estimates in these countries in Section 4. The data and model specification used for analysing agriculture’s role in poverty reduction are discussed in Section 5. In Section 6, the results obtained are used to simulate the effects of various drivers of agricultural growth on poverty in these countries. Section 7 draws together the main findings from a broad policy perspective.

3. Salient Features of Nepalese Economy\(^3\)

Nepal has experienced a downswing phase circumscribed by poverty and stagnation. Agriculture-essentially subsistence-is a source of livelihood for 70 per cent of the population. Disguised unemployment is pervasive; rural indebtedness as also poverty are high; and 74 per

\(^2\) GNI per capita is used to classify countries as low income, lower middle income and upper middle income. For details, see WDI 2011.

\(^3\) This draws upon an excellent review by Dahal (2011).
cent of households possess less than one ha of land. Recent comparison illustrates that Nepal’s economy is lagging behind other member countries in the SAARC region.

Macroeconomic indicators are worrying—a GDP per capita growth rate of 2.5 per cent annually with inflation hovering around 10 per cent. Merchandise exports have declined in recent years resulting in a huge trade deficit. A negative balance of payments with gross international reserves just enough to pay for imports of merchandise goods and services for a little over 7 months is a source of vulnerability. Although remittances rose markedly, their growth rate declined from 51 per cent in FY 2008/09 to 10.1 per cent during FY 2010/11. The FDI stagnated around Rs 58 billion in mid-March 2010. Earnings from tourism declined from 4.1 per cent of GDP in 1994-95 to 2.4 per cent in 2010/11. Although revenue/GDP ratio is estimated to be 15.3 per cent with growing fiscal deficit, internal revenue mobilisation is likely to fall short of supplementing capital expenditures. Capital expenditure (about 39 per cent of the estimated budget of Rs 385 billion for FY 2011/12) is much lower than required due to lack of enduring peace and stability and poor investment-friendly environment.

Nepal is going through a critical phase marked by growing inefficiency, corruption and political entrenchment that could jeopardise development. Although it enjoys a strategic location, its geophysical limitation and landlocked situation have impaired its prospects of enhancing its competitiveness and trade. In fact, in recent years, it has lost its comparative advantage in conventional exportable products at the regional and international markets, and new high-value crops suitable for exports. Commercialisation of agriculture is hampered by fragmented plots. Besides, inflow of FDI and domestic investment are adversely affected by inadequate infrastructure, and poor industrial relations with rigid labour laws and tax regulations. Apart from political instability, corruption is rife. Nepal is among the most corrupt countries in South Asia.

4. Poverty in Selected Asian Countries

Table 1 gives poverty estimates for selected low income countries in APR.

In Bangladesh, extreme poverty ($1.25/day) rose over the period 1983-1992, and then fell during 1996-2005. Nearly half the population was extremely poor in 2005. A similar pattern is revealed when the higher poverty line ($2/day) is used. Not surprisingly, about 82 per cent of the population was moderately poor in 2005.
Table 1: Poverty estimates in selected Asian countries

<table>
<thead>
<tr>
<th>Country</th>
<th>Year</th>
<th>Poverty Headcount (US$1.25/day)</th>
<th>Poverty Headcount (US$2/day)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bangladesh</td>
<td>1983</td>
<td>47.4</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1986</td>
<td>43.0</td>
<td>81.7</td>
</tr>
<tr>
<td></td>
<td>1988</td>
<td>52.5</td>
<td></td>
</tr>
<tr>
<td></td>
<td>1992</td>
<td>66.8</td>
<td>92.5</td>
</tr>
<tr>
<td></td>
<td>1996</td>
<td>59.4</td>
<td>87.5</td>
</tr>
<tr>
<td></td>
<td>2000</td>
<td>57.8</td>
<td>85.4</td>
</tr>
<tr>
<td></td>
<td>2005</td>
<td>49.6</td>
<td>81.3</td>
</tr>
<tr>
<td>Cambodia</td>
<td>1994</td>
<td>48.6</td>
<td>77.9</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>40.2</td>
<td>68.2</td>
</tr>
<tr>
<td></td>
<td>2007</td>
<td>25.8</td>
<td>57.8</td>
</tr>
<tr>
<td>Lao PDR</td>
<td>1992</td>
<td>55.7</td>
<td>84.8</td>
</tr>
<tr>
<td></td>
<td>1997</td>
<td>49.3</td>
<td>79.9</td>
</tr>
<tr>
<td></td>
<td>2002</td>
<td>44.0</td>
<td>76.9</td>
</tr>
<tr>
<td>Nepal</td>
<td>1985</td>
<td>78.1</td>
<td>93.4</td>
</tr>
<tr>
<td></td>
<td>1996</td>
<td>68.4</td>
<td>88.1</td>
</tr>
<tr>
<td></td>
<td>2004</td>
<td>55.1</td>
<td>77.6</td>
</tr>
</tbody>
</table>


Cambodia exhibited a sharp reduction in extreme poverty over the period 1994-2007, with a little over quarter of the population as extremely poor in 2007. A similar pattern is obtained when the higher poverty cut-off of $2/day is used, with nearly 59 per cent of the population as moderately poor in 2007.

Lao PDR recorded a reduction of about 12 percentage points in extreme poverty over a 10-year period, 1992-2002. However, the incidence of extreme poverty was high (44 per cent). Using the higher poverty cut-off point ($2/day), the reduction was lower (about 8 percentage points), with well over three-fourths of the population as poor.

In Nepal, extreme poverty fell from about 78 per cent to 55 per cent during 1985-2004—an annual reduction of about 1.21 percentage points. But well over half of the population was extremely poor in 2004. Moderate poverty also fell from over 93 per cent to about 78 per cent—an annual reduction of 0.83 percentage point. So, among all these low income countries, extreme poverty was highest in Nepal (subject of course to the caveat that years of comparison are not the same) but moderate poverty was lower than the highest in Bangladesh. So the challenge of poverty reduction in Nepal is daunting.

These statistics, however, do not reveal large within-country variations, especially between remote mountainous regions and the rest. The following box illustrates this.

**Box 1: Interregional variations in poverty in Bhutan, Nepal and India**

National poverty estimates do not reveal the differences between remote mountainous and other regions. Not only is the poverty incidence often much higher in the former but the rate of reduction over time is also much slower despite substantial economic growth. Some illustrative evidence, based on a detailed analysis of household data for Nepal and Bhutan is summarised below.
In Nepal, poverty is much higher in the mountainous region. By contrast, while the mountainous parts of India are not poorer than the rest, there are marked disparities among the different states of the Indian Himalayan region. Although all of Bhutan is mountainous, Eastern Bhutan lags far behind the rest in terms of poverty and other proximate indicators of well-being (e.g. access to basic amenities and connectivity to markets).

A striking contrast emerges from a comparison of poverty across different regions in Nepal. In the mountains and hills, the headcount ratio of poor declined from 47.7 per cent in 1996 to 40 per cent in 2003; in the plains, the reduction was from 40.3 per cent to 27.6 per cent; and, in Kathmandu Valley, from a low of 7.2 per cent to 3.7 per cent. In both Bhutan and Nepal, there is a strong systematic relationship between isolation and poverty, as remoteness in terms of limited access to roads, markets and public services (mainly education and health care) is correlated with prevalence of poverty. Besides, greater vulnerability to natural hazards (e.g. wind storms, landslides) is compounded by absence of social protection.

The policy implications of such disparities in living standards are profound. Whether low population densities in such remote areas impede policy outreach merits close scrutiny.

Source: ICIMOD (2010), and IFAD (2011).

Rural poverty has declined rapidly in APR over the past decade (from 1057 million to 687 million). This has been on account of an extraordinarily fast decline in number of rural poor in East Asia. In the last three decades, poverty in this sub-region has declined by about two thirds. While it had over 500 million rural poor two decades ago, the number today stands at only 117 million. Rural poverty in South East Asia declined too over the period. However, the decline was seen only in the last decade. Amongst the Asia-Pacific sub-regions, South Asia has the largest number of poor rural people. Further, the absolute number of rural poor in this region increased before it started to decline somewhere around 2000. Despite the reduction in South Asia, the number of rural poor today is higher than what it was two decades earlier (IFAD, 2011).

Despite wide-ranging diversities in the region, many poor rural people in Asia and the Pacific Region are either landless or own a limited piece of land, possess large families, are less educated and have limited access to credit and technology. In addition, lack of market information, business and negotiating experience and collective organisations deprive them of the power to compete on equal terms in the marketplace. Box 2 delineates the characteristics and determinants of poverty in Laos and Cambodia.

A stylized fact about rural poverty in many parts of Asia and the Pacific Region is that the poorer rural households derive the highest proportion of their incomes from farming and agricultural labour, while the better-off households derive the most from non-farm activities. Given the constraints on farm expansion and continuing growth of the rural population, greater attention is being given to non-farm activities in view of their potential for economic development and poverty reduction. In fact, countries that have succeeded in sustained rural poverty reduction have generally promoted both agriculture and non-farm rural economy (IFAD, 2011). Occupational diversification is also a major way of managing risk for poor people with few risk management options. Development of rural non-farm economy (RNFE) is especially important for women and groups that are disadvantaged in agriculture.
It is now well recognized that income poverty is poverty of only one kind. Economists and policymakers, following Amartya Sen’s seminal contribution, have argued powerfully for the need to take a multidimensional approach to poverty and deprivation. Multidimensional poverty includes other intrinsically important dimensions along with income. For instance, rural poverty can be defined primarily in terms of non-income deprivations. Interlocking disadvantages often reinforce each other, and thus contribute to making it even more difficult to move out of poverty. Alkire and Santos (2010) construct a multidimensional poverty index (MPI) for households across 104 countries. The MPI is measured using ten indicators based on health (mortality and nutrition), education (years of schooling and child enrolment) and standard of living (electricity, sanitation, water, flooring, cooking fuel and ownership of consumer durables). The indicators chosen are along the lines of the Millennium Development Goals (MDGs).

Box 2: Determinants of rural poverty in Laos and Cambodia

In Laos, poverty is primarily a rural problem. In 2002-03, about 86 per cent of the poor lived in rural areas. This fell to about 81 per cent in 2007/8. Also, the rural headcount index was just under twice as high as in urban areas (31.7 per cent and 17.4 per cent, respectively). The spatial and temporal variations in poverty in Laos can be explained by geography, market access through roads, and ethnicity. The overall poverty is higher in the Uplands (relative to the Lowlands); it is also higher in villages without access to roads (relative to those with access); it is higher among the Mon-Khmer and Hmong-Iu Mien minorities, relative to the Lao-Tai majority.

In Cambodia, the chances of being poor vary negatively with household head’s age but at a diminishing rate. Large households are more likely to be poor. On the other hand, male-headed households and Khmer households are less likely to be poor. There are lower risks of poverty among small and large farmers, relative to the landless and marginal farmers. Security of land title has a significant role in lowering the risk of poverty. Presumably, this acts as an incentive to making longer-term investments in technology that enhance yields. Educational attainments have large poverty reducing effects. Diversified sources of income act as a cushion against market and other shocks. The larger the proportions of households using electricity and irrigation in a village, the lower were the chances of being poor. As lack of market access constrains income earning opportunities (for example, remunerative prices for agricultural produce), access to an all-weather road lowers the risk of poverty, pointing to the priority of expanding access to all-weather roads in a rural poverty reduction strategy.

Source: Gaiha and Annim (2010), and Gaiha and Azam (2011).

While the estimates of income poverty and MPI are likely to differ, it is striking that some of the low income countries in APR have high incidences of both income poverty (>0.25 and MPI (>0.25). Regardless of whether income poverty is estimated using the $1.25 or $2 cut-off, Bangladesh, Cambodia, Laos, and Nepal exhibit high incidences of both income poverty and MPI. This overlap should not be taken to imply that mitigating income deprivation alone will help mitigate others. On the contrary, a broader anti-poverty agenda is needed that will address interlocking but distinct deprivation in income, health and education.

Within rural societies, women, youth and indigenous people are often disproportionately affected by disadvantages that tend to make mobility out of poverty even harder. However, people in

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4 Sen (1999)
these groups possess capabilities and assets (e.g. indigenous knowledge systems) that could be tapped to enhance their well-being. Unfortunately, social and political power distribution tends to undermine their ability to utilize these assets to move out of poverty (IFAD, 2011).

### 4.1 Structural Characteristics

Although all four countries are classified as low income, there are some differences. Going by Table 2, Nepal is the poorest in terms of GDP per capita, followed by Bangladesh, Cambodia and Lao PDR. Their growth rates differ too over the period 2005-2010. The lowest growth was recorded by Nepal (2.5 per cent annually), more than twice as high by Bangladesh (5.6 per cent), slightly higher than Bangladesh’s by Cambodia (6.10 per cent) and highest by Lao PDR (7.4 per cent). Their dependence on agriculture varied too, as shown in Table 3.

#### Table 2: GDP per capita PPP (constant 2005 international $)

<table>
<thead>
<tr>
<th>Year</th>
<th>Bangladesh</th>
<th>Cambodia</th>
<th>Laos</th>
<th>Nepal</th>
</tr>
</thead>
<tbody>
<tr>
<td>2001</td>
<td>1002.7</td>
<td>1100.5</td>
<td>1399.1</td>
<td>924.0</td>
</tr>
<tr>
<td>2002</td>
<td>1028.9</td>
<td>1156.5</td>
<td>1458.1</td>
<td>904.1</td>
</tr>
<tr>
<td>2003</td>
<td>1065.1</td>
<td>1237.7</td>
<td>1523.6</td>
<td>918.9</td>
</tr>
<tr>
<td>2004</td>
<td>1114.6</td>
<td>1348.1</td>
<td>1596.8</td>
<td>941.2</td>
</tr>
<tr>
<td>2005</td>
<td>1164.6</td>
<td>1508.0</td>
<td>1684.6</td>
<td>953.8</td>
</tr>
<tr>
<td>2006</td>
<td>1226.4</td>
<td>1650.9</td>
<td>1800.9</td>
<td>966.4</td>
</tr>
<tr>
<td>2007</td>
<td>1290.7</td>
<td>1799.0</td>
<td>1907.4</td>
<td>980.3</td>
</tr>
<tr>
<td>2008</td>
<td>1356.3</td>
<td>1898.1</td>
<td>2018.7</td>
<td>1021.0</td>
</tr>
<tr>
<td>2009</td>
<td>1419.0</td>
<td>1878.7</td>
<td>2139.3</td>
<td>1047.0</td>
</tr>
<tr>
<td>2010</td>
<td>1488.3</td>
<td>1968.1</td>
<td>2307.8</td>
<td>1075.4</td>
</tr>
</tbody>
</table>

Source: WDI, 2011

Bangladesh’s share of agriculture in GDP was lowest-about 19 per cent. There was a slight reduction over the period 2005-2010. Cambodia had the highest share along with Nepal (about 36 per cent). While Cambodia witnessed a slight increase over the period 2005-2010 (from 32.4 per cent to 36 per cent), Nepal did not record any change. In Lao PDR, however, there was a moderate reduction (from 36.4 per cent to 33 Per cent).

As cereals matter for food poverty (defined generally in terms of calorie deficiency relative to a norm), the rate at which their yields grow matters (Gaiha and Annim, 2010; Gaiha and Azam 2011; IFAD, 2011). Comparison of cereal yields growth rate over the period 1999-2005 shows that the lowest growth was recorded by Nepal (1.8 per cent annually), a slightly higher rate by Bangladesh (2.8 per cent), Lao PDR (3.5 per cent), and Cambodia (4 per cent)\(^6\).

\(^6\) For details, see WDR (2008)
Table 3: Share of agriculture in GDP (%)  

<table>
<thead>
<tr>
<th>Year</th>
<th>Agriculture, value added (% of GDP)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Bangladesh</td>
<td>Cambodia</td>
</tr>
<tr>
<td>2001</td>
<td>24.1</td>
<td>36.2</td>
</tr>
<tr>
<td>2002</td>
<td>22.7</td>
<td>32.9</td>
</tr>
<tr>
<td>2003</td>
<td>21.8</td>
<td>33.6</td>
</tr>
<tr>
<td>2004</td>
<td>21.0</td>
<td>31.2</td>
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<tr>
<td>2005</td>
<td>20.1</td>
<td>32.4</td>
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<tr>
<td>2006</td>
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<td>2007</td>
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<td>2008</td>
<td>19.0</td>
<td>34.9</td>
</tr>
<tr>
<td>2009</td>
<td>18.7</td>
<td>35.7</td>
</tr>
<tr>
<td>2010</td>
<td>18.6</td>
<td>36.0</td>
</tr>
</tbody>
</table>

Source: WDI 2011

As agricultural ODA helps supplement public expenditure in agriculture—especially in low income countries—some illustrative estimates point to varying dependence of these countries on the former over the period 2003-2005. The share of agricultural ODA in total ODA was lowest in Bangladesh (2.4 per cent) and highest in Lao PDR (13 per cent). Between this range were Nepal (7.5 per cent) and Cambodia (10.9 per cent). That these shares do not vary in accordance with the need to raise cereal yields growth rates or even relative importance of agriculture in GDP is worrying.

5. Data and Results

5.1 Results

Our poverty estimates are the new World Bank headcount poverty estimates, based on the poverty lines of US$1.25 and US$2 per day, adjusted by purchasing power parity (PPP) in 2005 (Chen and Ravallion 2008). While the poverty estimates based on US$1.08 per day in 1993 PPP were widely used in the studies of the first Millennium Development Goal (MDG1) target, the new poverty estimates cover a larger number of countries and are assumed to be more reliable (ibid.). These estimates are taken from the World Bank’s PovcalNet\(^7\) website and World Development Indicators 2010 (World Bank, 2010). They cover 21 countries\(^8\) in the Asia and the Pacific region over the period 1980-2006.

The variables used in the regression analyses are listed in annex A with their data sources. Most of the variables are in logarithm to facilitate computation of elasticity estimates. Institutional data were taken from the World Bank’s World Governance Indicators database. The data cover 1998,


\(^8\) They are: Bangladesh, Bhutan, Cambodia, China, India, Indonesia, the Islamic Republic of Iran, Kazakhstan, the Kyrgyz Republic, the Lao People’s Democratic Republic, Malaysia, Nepal, Pakistan, Papua New Guinea, the Philippines, Sri Lanka, Tajikistan, Thailand, Timor-Leste, Uzbekistan and Viet Nam.

Different specifications are used to capture unobservable country-specific effects and to allow for endogeneity of some key variables (e.g. agricultural value added, public expenditure in agriculture and ODA in agriculture). These are discussed in annex B.

### 5.2 Results

This section discusses econometric results based on the different specifications, based on a sample of countries in the APR.\(^10\) The key findings are: (i) agricultural expenditure (first lag) and agricultural ODA positively and significantly affect (the first lag of) agricultural value added; (ii) poverty headcounts are negatively associated with log GDP per capita, which is positively affected by (lagged) agricultural value added; (iii) poverty is positively associated with the expenditure/income Gini coefficient, but the estimate is not significant. Thus agricultural ODA indirectly reduces poverty after taking account of its endogeneity; and public expenditure in agriculture also indirectly reduces poverty (i.e. through its positive effects on agricultural value added and GDP).

The elasticity of poverty with respect to the second lag of agricultural ODA is -0.092 in Case 1 and -0.128 in Case 2.\(^11\) In Case 1 (or Case 2), a 1-per-cent increase in annual agricultural ODA on average reduces poverty by 0.092 per cent (or 0.128 per cent), given the baseline poverty at US$2 per day in 2006. As the effect of agricultural ODA on poverty is cumulative over the years, the long-term effect of an increase in agricultural ODA on poverty (e.g. from 2006 to 2015) can be substantial.

The elasticity of poverty with respect to the first lag of agricultural expenditure in Case 3 is 0.351, which is larger than 0.202 in Case 1, given the larger coefficient estimate of lagged agricultural value added in the GDP equation (2.582) in Case 3. Poverty elasticity with respect to agricultural expenditure is larger than that of agricultural ODA.\(^12\) In Case 4, the poverty elasticity with respect to fertilizer use is 0.287. When agricultural investment is used, in Case 5, the corresponding poverty elasticity is -0.349. This result, though plausible, cannot be accepted at face value, given the extrapolation of investment. Moreover, the small sample (26) precluded the use of country dummies.

The same models are also applied to the poverty headcount ratio on the US$1.25-per-day poverty line. The results are similar, except that the coefficients are generally higher, implying greater sensitivity of poverty indices at the lower poverty line.

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\(^10\) For details, see annex B.

\(^11\) For details of Cases 1-5, see annex B.

\(^12\) We should not, however, straightforwardly conclude that agricultural ODA is more effective than agricultural expenditure, as the estimates of agricultural ODA are extrapolated.
A result of considerable policy significance is that, in all cases, poverty elasticity with respect to agricultural value added is substantially larger than that of GDP. In fact, it is almost twice as large as the corresponding elasticity with respect to GDP.

In sum, the results corroborate robustly that: (i) agriculture is important not just for economic growth, but also for poverty reduction; and (ii) increases in agricultural ODA, expenditure, investment and fertilizer (as a proxy for technology) tend to reduce poverty. Thus both national governments and donors have important roles in accelerating agricultural growth and poverty reduction.

6. Simulations

We report here selectively our simulation results on the feasibility of MDG1 on the poverty lines of $2/day and $1.25/day, respectively. As several different specifications are used, a range of estimates is obtained.

In each case, we first compute expected poverty in 2015 based on the assumption that predetermined variables, such as agricultural ODA, expenditure and investment, follow the historical trend in 1980-2006. If expected poverty in 2015 is less than 50 per cent of poverty level, based on US$2 per day in 1990 (or MDG1), it is inferred that the country is on track to achieve MDG1. In each case, MDG1 is compared with the expected poverty in 2015, and the necessary increase in agricultural ODA (or agricultural expenditure, fertilizer use or agricultural investment) is computed for the period 2007-2013, relative to the baseline scenario, where these variables follow the historical trend.

While the necessary increase in factors associated with growth in agriculture varies for different countries, depending on the current level of poverty or the share of agriculture in GDP, our simulations confirm that increases in agricultural ODA, agricultural expenditure, fertilizer use and agricultural investment are important in achieving MDG1. As the results are voluminous, our remarks are selective.

As may be noted from Table 4, the prospects of achieving MDG 1 ($2/day) are bleak for low income countries—especially for the 4 selected for the present study. The required increases vary with the different specifications and the details are given in Imai et al. (2011). To avoid repetition, we shall confine our remarks to the cases 1, 4 and 5 to illustrate the magnitudes of key drivers of agricultural growth in order to achieve halving of moderate poverty.

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13 Note that the simulation results are essentially back-of-envelope calculations. A cautious interpretation is necessary, given that: (i) estimates of agricultural ODA and agricultural investment are extrapolated; (ii) the impact of each factor on poverty differs across countries, but the elasticities are averaged across countries (and being averages of large samples are more stable); and (iii) simulations are carried out under the assumption of ‘other factors being unchanged’. But these limitations are imposed by patchy data on key variables.
For low income countries in general, the required increases (or annual growth rates) are not too daunting (over and above the historical rates). ODA in agriculture must increase at an annual rate of 14 per cent; agricultural expenditure at a rate of 8 per cent; fertilizer use at a rate of 3 per cent and agricultural investment at 7 per cent. Among the 4 countries, Cambodia’s requirements are mostly large: agricultural ODA should increase at 12 per cent annually; agricultural expenditure, as also investment, at 7 per cent; and somewhat surprisingly fertilizer use at a low rate of 2 per cent. In comparison, Nepal’s requirements are lower: agricultural ODA must increase at an annual rate of 9 per cent; agricultural expenditure at 5 per cent; fertilizer use at a faster rate of 4 per cent; and agricultural investment at a slightly lower rate of 6 per cent. Bangladesh’s requirements are lower than those of Nepal. Lao PDR would require rates of growth of ODA and agricultural expenditure that are same as Nepal’s but lower rates of growth of fertilizer use and agricultural investment.

If we base our simulations on the poverty line of $1.25/day (or MDG1 of halving extreme poverty by 2015), the outlook for low income countries is not so bleak. Bangladesh, for example, is on track to achieving MDG 1 but the remaining three will need greater resources than implied by historical trends (but lower than for halving moderate poverty). Cambodia’s ODA growth rate, for example, would be 7 per cent annually (as compared with 12 per cent for halving moderate poverty) and agricultural expenditure would be 3 per cent (as against 7 per cent). Nepal’s ODA growth rate would also be considerably lower (3 per cent as compared with 9 per cent annually in the previous case), as also that of agricultural expenditure (1 per cent as compared with 5 per cent in the previous case). So the prospects of halving extreme poverty seem less daunting.

However, there are two important caveats. Some of these drivers of agricultural growth have declined (for example, ODA in agriculture). So even modest increases are likely to be difficult. Agricultural investment poses another difficulty—lack of reliable estimates for recent years. For our analysis, these estimates are extrapolations of limited and patchy data. For Nepal, however, we have fairly detailed and recent agricultural investment estimates. A graphical representation
in Fig: 1 shows a decline in the share of agricultural investment in total investment, with an annual reduction of 3.20 per cent (CBS 2009, Thapa 2011). So a reversal of these trends is a first priority, followed of course by required increases. Whether these increases are feasible depends crucially on whether donors would fulfill their commitments with recession looming large in the global economy and limited fiscal space among the low income countries.

**Fig: 1 Share of agricultural investment in total investment in Nepal (%)**

Simulation results are also aggregated for specific categories: (i) whether a country is in the low- or middle-income group; (ii) whether it is among the top 30 countries in the developing world in terms of aggregate governance or institutional quality; (iii) whether the trade share (or the share of imports and exports in GDP) is low (below 50 per cent), middle (50-100 per cent) or high (above 100 per cent); and (iv) whether the rating of the World Bank’s Ease of Doing Business Index is low (above 150), middle low (100-150), middle high (50-100) or high (below 50). This index ranks countries according to their regulatory environment or ease of doing business, ranging from 1 to 183. A high ranking means that the regulatory environment is more conducive to the starting and operation of a local firm. The index averages a country's percentile rankings on a variety of indicators. This is meant to supplement the institutional analysis. A selection of the results is given below.

As expected, low-income countries (including Nepal, Cambodia and Lao PDR) would need a higher increase in agricultural ODA (an annual increase of 14 per cent over 2007-2013 for US$2; a 8 percent increase for US$1.25, over and above the baseline scenario) than would middle-income countries (an 11 per cent increase over 2007-2013 for US$2; a 4 per cent increase for US$1.25). Similarly, the necessary increase in agricultural investment over 2007-2013 is substantially higher for low-income countries (7 per cent annually for US$2) than for middle income ones (1 per cent for US$2). For the purpose of poverty reduction in terms of both

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14 Data are available at [www.doingbusiness.org/rankings](http://www.doingbusiness.org/rankings).

15 Recall that Cases 1 and 2 differ as to whether their effects are estimated jointly or singly. Given the overlap between the two variables, more precise estimates are ruled out.
US$1.25 and US$2 per day, donors should mainly concentrate ODA in the agriculture sector of low-income countries, but without neglecting middle-income ones.

On the issue of governance, countries that rate low (e.g. Nepal, Cambodia) would need more agricultural ODA, agricultural expenditure, fertilizer use or agricultural investment to achieve MDG1 on both US$2- and US$1.25-per-day criteria. In particular, the requirement for increasing agricultural investment seems demanding for these countries. A policy dilemma that must be confronted is whether ‘triggers’ for institutional reform could partly compensate for higher transfers of resources to agriculture in low-rated countries.16

By contrast, trade openness is not amenable to easy generalization, partly because some of the poorest countries are highly trade dependent (e.g. Cambodia), but more affluent ones as well (e.g. China). Countries with low trade openness would need higher levels of increase in agricultural ODA, agricultural expenditure or fertilizer use, but lower levels of increase in agricultural investment. While a higher degree of trade openness is generally associated with economic growth and poverty reduction, it may also lead to the neglect of agriculture if not globally competitive. Whether a quick transition out of agriculture is desirable, let alone feasible, seems contentious. Our results imply that, even if a country is open to the rest of the world, a substantial agricultural investment is needed for poverty reduction for MDG1 at both US$1.25 and US$2 per day.

Finally, countries with less business-friendly regulatory environments (e.g. Nepal) would need larger increases in agricultural ODA, agricultural expenditure, fertilizer use and agricultural investment. As in the case of governance or institutional quality, the policy dilemma is whether efforts should be directed towards improving the business environment and/or ensuring greater transfer of resources to agriculture.

7. Concluding observations

This paper has examined whether accelerated growth of agriculture – through agricultural expenditure, ODA or investment – makes a difference in the prospects of achieving MDG1 in selected low income countries (Bangladesh, Nepal, Cambodia and Lao PDR) in Asia and the Pacific region (using both US$1.25- and US$2-per-day poverty criteria). The prospects of achieving MDG1 ($2/day) are bleak if historical trends in drivers of agricultural growth continue over the period 2007-2013. The prospects are slightly less bleak if the lower poverty line of $1.25/day is used, in so far as Bangladesh is on track but not the remaining three.

Our analysis confirms robustly that increases in agricultural ODA, agricultural expenditure, fertilizer use or agricultural investment would accelerate agricultural and GDP growth and, consequently, improve the prospects of achieving the more ambitious MDG1 (US$2 per day). The resource requirements are substantially lower in these low income countries when the MDG1 is defined at the lower poverty line ($1.25/day).

16 A few institutional triggers suffice here. For the rule of law to prevail, a better reporting of crime and insurgencies may help; for the management of corruption, an initiative such as the right to information, which allows official documents to be placed in the public domain, has had visible effects in India; and for the right to property, land titling may facilitate other protective measures.
Aggregation of the simulation results for individual countries into various categories reveals that low-income countries (all four countries studied are included) with a low level of governance or institutional quality (all four included with some variation), or with low ease of doing business (all four included with some variation), would need larger increases in agricultural ODA, expenditure or investment to achieve MDG1 at both US$2 and US$1.25 per day. These results raise two related but distinct policy dilemmas: one is the trade-off between real resource transfer to agriculture and institutional reform, and the other is a similar trade-off between resource transfers and the business environment. Our earlier work discussed ‘triggers’ for institutional reform (e.g. right to information, land titling, better reporting of crime and insurgencies). While some examples exist of how well these triggers work, policymakers and donors need to reflect on more-cost-effective and more-encompassing triggers, as institutional reform is not merely a by-product of growth or a causal factor. Indeed, arguments abound suggesting that institutional reform and growth may occur simultaneously, making it harder to pinpoint areas of intervention.

Another important insight that our analysis yields is that not just national governments, but also donors, need to commit larger resources to agriculture – especially in many of the poorest countries. Mechanisms that would ensure larger budgetary outlays and donor funds for agriculture, and their allocation between rural infrastructure and sustainable technology, call for deep scrutiny.

A specific concern, however, is the limited fiscal space in the selected countries (with some variation). While recent estimates of fiscal deficits are available for a small number of countries, it is noteworthy that, while Nepal and Cambodia had low fiscal deficits in 2001-06, Bangladesh’s was relatively high. So, although fiscal space may not be a severe constraint, larger public outlays for agriculture-especially public investment-, may impose difficult choices. A related concern is, of course, enhanced efficiency of public expenditure in agriculture.

In conclusion, while the challenge of reducing the scourge of poverty is daunting, the resource requirements for accelerated agricultural growth and institutional reforms delineated here could be the basis of a comprehensive and workable policy agenda.

Annex A. List of variables

log Poverty: log of poverty headcount ratio based on US$2-per-day poverty line in t, 1980-2006, for the country \(i\) (World Bank 2010; PovcalNet)

log Poverty Gap: log of poverty gap based on US$2-per-day poverty line (World Bank 2010; PovcalNet)

log GDP pc: log of GDP per capita

log Agri VA(-1): log of agricultural value added per agricultural worker in the previous period, t-1 (World Bank 2010)

log Fertilizer Use(-1): log of fertilizer consumption (kg per ha of arable land) (World Bank 2010)


log Agri ODA(-1): log of ODA to agriculture per rural population (World Bank 2007, 322-323; World Bank 2010)

Subscripts \(t\) and \(i\) are omitted below.

\( \log \text{Agri Investment} \): log of investment in agriculture sector per rural population (investment data from Harvard University's Centre for International Development)

\( \log \text{Gini Coef.} \): log of Gini coefficient of income/consumption distribution (PovcalNet)

Annex B. Econometric specifications

Different specifications are used to capture unobservable country-specific effects and to allow for the endogeneity of some key variables (e.g. agricultural value added \([\text{Agri VA}]\), public expenditure in agriculture \([\text{Agri Expenditure}]\) and ODA in agriculture \([\text{Agri ODA}]\)). These are discussed below.\(^{19}\)

**Case 1**

The following system of equations is estimated by three stage least squares (3SLS) to identify direct and indirect determinants of poverty in a country using panel data.

\[ \log \text{GDP pc}_i^t = \alpha_0 + \alpha_1 \log \text{Agri VA}_{i,t-1} + \delta_1 \log \text{Agri ODA}_{i,t-1} + \delta_2 \log \text{Agri Expenditure}_{i,t-1} + \delta_3 \log \text{Gini Coef.}_{i,t-1} + \delta_4 \log \text{Log Poverty}_{i,t-2} + \delta_5 \log \text{Log Agriculture}_{i,t-2} + \delta_6 \log \text{Log Gini Coef.}_{i,t-2} + D_i \delta_0 + \epsilon_0 \]  

(1)

where \(i\) denotes country and \(t\) denotes year (from 1980 to 2006), \(\log \text{GDP pc}_{i,t}\) is log of GDP per capita, and \(\log \text{Agri VA}_{i,t-1}\) is log of agricultural value added per agricultural worker in the previous year, \(t-1\). Following Imai, Gaiha and Thapa (2010), we consider the effect of agricultural income in the previous period on GDP per capita. In this case, we take account of country fixed effects by including \(D_i\), a vector consisting of country dummy variables in each equation.\(^{20}\) However, because we do not have sufficient observations in our unbalanced panel data, we cannot include year dummies. \(\epsilon_0\) (as well as \(\epsilon_1, \epsilon_2\), and \(\epsilon_3\)) is an error term that is assumed to be independent and identically distributed.

\[ \log \text{Agri VA}_{i,t} = \beta_0 + \beta_1 \log \text{Agri Expenditure}_{i,t-1} + \beta_2 \log \text{Agri ODA}_{i,t-1} + \beta_3 \log \text{Gini Coef.}_{i,t-1} + \beta_4 \log \text{Log Poverty}_{i,t-2} + \beta_5 \log \text{Log Agriculture}_{i,t-2} + \epsilon_1 \]  

(2)

where agricultural value added is estimated by public expenditure on agriculture/agricultural expenditure and ODA in agriculture (or agricultural ODA), both normalized by rural population. \(\log \text{Agri Expenditure}_{i,t-1}\) (or log of lagged agricultural expenditure) is a predetermined and weakly exogenous variable and is used as an instrument for \(\log \text{Agri VA}_{i,t-1}\).

\[ \log \text{Log Poverty}_{i,t} = \gamma_0 + \gamma_1 \log \text{GDP pc}_{i,t} + \gamma_2 \log \text{Gini Coef.}_{i,t} + \gamma_3 \log \text{Log Poverty}_{i,t-1} + \gamma_4 \log \text{Log Agriculture}_{i,t-1} + \gamma_5 \log \text{Log Gini Coef.}_{i,t-1} + \epsilon_{t-1} \]  

(3)

where \(\log \text{Log Poverty}_{i,t}\) is log of poverty headcount ratio (or poverty gap), based on the US$2 (or US$1.25)-per-day poverty line in \(t\), for country \(i\). \(\log \text{Gini Coef.}_{i,t}\) is log of Gini coefficient of income distribution. Here, poverty is premised as a function of the level of overall economic development, measured by GDP per capita, and the degree of income inequality in a country. It is assumed that a higher inequality is associated with a higher level of poverty. While GDP is hypothesized to reduce poverty, inequality increases it.

\[ \log \text{Agri ODA}_{i,t} = \delta_0 + \delta_1 \log \text{Agri ODA}_{i,t-2} + \delta_2 \log \text{Agri VA}_{i,t-2} + \delta_3 \log \text{Log Poverty}_{i,t-2} + \delta_4 \log \text{Log Agriculture}_{i,t-2} + \epsilon_{t-2} \]  

(4)

[log Agri ODA\(_{i,t}\)] is estimated by its lag and [log Agri VA\(_{i,t-2}\)] to take account of a likely two-way causality between agricultural value added and agricultural ODA. [log Poverty\(_{i,t}\)] is either poverty headcount ratio (or poverty gap) at US$2 (or US$1.25)-per-day poverty line.

**Cases 2 and 3**

Case 2 is the same as Case 1 except that log Agri Expenditure (first lagged) is dropped from equation (2) on the presumption that a part of agricultural ODA is used for public expenditure in agriculture. Owing to lack of data, however, it is difficult to measure the overlap between them.\(^{21}\) Hence, we use only log of Agri ODA (first lagged) in Case 2, or only log of Agri Expenditure (first lagged) in Case 3, in order to identify the effect of each factor on agricultural value added. In Case 3, equation (4) for log Agri ODA\(_{i,t-2}\) is dropped. Country fixed effects, or \(D_i\), are included in these cases.

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\(^{19}\) For further details, see Imai et al. (2011).

\(^{20}\) These are unobservable country-specific effects (e.g. how ‘welfarist’ is a political regime?) that are not captured by any of the right side variables used in the GDP equation.

\(^{21}\) In Cambodia, for example, public expenditure on agriculture fluctuates with ODA.
Case 4

In another specification, we have replaced \([\log \text{Agri Expenditure}]_{t-1}\) by \([\log \text{Fertilizer}]_{t-1}\) in equation (2) in Case 3. Agricultural ODA is not inserted in this case as its coefficient estimate turned out to be non-significant.

\[
[\log \text{Agri VA}]_{t-1} = \beta_0 + \beta_1[\log \text{Fertilizer}]_{t-1} + D_i\beta_3 + \epsilon_t
\]

(2)'

where \([\log \text{Fertilizer Use}]_{t-1}\) is log of fertilizer consumption (kg per ha of arable land).

Case 5

\[
[\log \text{GDP pc}]_t = \alpha_0 + \alpha_1[\log \text{Agri VA}]_{t-1} + \epsilon_t'
\]

(1)'

\[
[\log \text{Agri VA}]_{t-1} = \beta_0 + \beta_1[\log \text{Agri Investment}]_{t-1} + \epsilon_t'
\]

(2)'

\[
[\log \text{Poverty}]_t = \gamma_0 + \gamma_1[\log \text{GDP pc}]_t + \gamma_2[\log \text{Gini Coef.}]_t + \epsilon_t'
\]

(3)'

In Case 5, we replace fertilizer by log of lagged investment in agriculture per capita for rural areas. Agricultural ODA is not included in equation (2)' as the coefficient estimate is not significant. Here, due to the small number of observations on agricultural investment (\([\log \text{Agri Investment}]_t\)), we cannot include country or year dummies. Also, as the data on agricultural investment are highly limited, we should interpret the results with caution.22

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22 Agricultural investment estimates are available only for 1980-1992 for a limited number of countries. Hence we have regressed agricultural investment on total capital formation and agricultural expenditure during 1980-1992. Based on the regression results, we obtained out-of-sample predictions of agricultural investment in 1993-2006.
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Strategic Process Models for Sustainability

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Abstract\textsuperscript{A}

The objective of this paper is to explore strategic process models for sustainability. Strategic management helps deal with “messy” problems by integrating multiple, even conflicting, factors through models of strategic processes. A survey of strategic process research provides five broad overlapping but distinct models that have immense potential. These models include guided evolution, learning and competencies, institutional and structuration, complexity, and critical and postmodern approaches. These strategic process models could be further integrated for developing actionable knowledge and knowledgeable practice of sustainable management in organizations in the future.

1. Introduction

The study of sustainability is scattered over numerous disciplines and fields of research. These disciplines have their favorite perspectives and appear to explain different aspects of the same organizational reality using diverse theories. According to Garud and Van de Ven (2001), “It is easy to get lost in the complexities theories and observations of strategic organization change processes unless we possess a systematic way of understanding this ever growing literature” (p. 42). Therefore, it may make sense to combine different explanations and come up with a few competing and complementary models that can help us understand and guide the theory and practice of sustainable management. The modern concept of strategy refers to the pattern of decisions and actions over time (Mintzberg, 1978). The field of strategy—strategic management—is distinguished by its integrative approach, which brings together perspectives from various disciplines to propose models of strategic processes. These models of strategic processes are particularly relevant for problems that are termed as “wicked” or “messy” (Rittel and Webber, 1973) such as the issue of sustainability in organizations. “Wicked” problems are the result of “organized” complexity (that can’t be dealt with by a random sample) and are characterized by interconnectedness, complicatedness, uncertainty, ambiguity, conflict as well as social constraints. Wicked problems may need participative, adversarial, integrative, and managerial thinking process, such as involved in dialectical inquiry and devil’s advocacy rather than simply expert methods or atomistic solutions (Mason and Mitroff, 1981).

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Sustainability has been thought in terms of economic prosperity, social equity, and environmental integrity (Bansal, 2005). Thus, organizations may adopt sustainability for competitiveness, legitimacy, and social responsibility (Bansal and Roth, 2000; Levy, 1997). Scholars have reflected on the past accomplishments and future challenges (e.g., Starik and Marcus, 2000) and suggested various paradigms for organizations to be technocentric, econocentric, and sustaincentric (Gladwin, Kennelly, and Krause, 1995; Shrivastava, 1995). How does strategic management integrate various factors to deal with the wicked problems such as sustainability? A review of literature on strategic processes may reveal an answer to this question. In our search, we found several theoretical models that could be combined in a single process model or could be represented as separate models (Mintzberg, 1990). However, we were immediately faced with the question: How would these different models combine in practice? A review of recent qualitative research helped identify five broad overlapping but distinct models that can be blended further for sustainable management. These models integrate economic, social, cultural, political, technological, and other influences through various processes to induce inertia as well as change in distinct ways in varied contexts.

The objective of this paper is to explore the strategic process models for sustainability. The paper is organized as follows. First, we define the concept of process used here and its relevance for a qualitative approach. Then, we provide an introduction to the strategic process literature in order to provide its background and overview. Next, we present five broad models that can be used for research and study on sustainable management in organizations. Finally, we conclude the chapter by reviewing the lessons learned, limitations and avenues for future research. It is expected that sustainable management research and practice will benefit from the models of strategic processes presented here.

2. The Concept of Process: A Qualitative Approach

To examine the strategic process models for sustainability, we will propose models based on a rich concept of the process that is used in qualitative studies. Therefore, let us begin by clarifying the two critical issues: The concept of process and the importance of examining it in in-depth qualitative studies.

First, it is important to examine what concept(s) of the process is (are) being used in a study. Van de Ven (1992) and Mohr (1982) propose three views of process: a) Process is used to explain causation between the variables to test variance theories without directly observing the process. Consistent with Van de Ven and Huber (1990), we agree that this is a highly restricted use of the process. b) Process is frequently used as a category of concepts that refer to actions of individuals or organizations. For example, Priem (1992) and Miller and Friesen (1984), among others, measured strategy making processes, such as scanning, analysis, and planning. In this view, the process constructs are operationalized as variables. What is measured is the change over different points of time rather than the ‘how’ aspect of change. In other words, similar to the first concept of process, this conception may not require directly examining the activities involved. c) The third use of process is as a sequence of steps that describes the pattern over
time, which is consistent with the dictionary meaning of the term process. For example, Cohen, March, and Olsen (1972), Greiner (1972), Mintzberg, Raisinghani, and Theoret (1976), and Quinn (1980) examined various processes of change using different theories. This last view provides the richest concept of the process and requires a direct examination of the activities involved. Therefore, in this paper, we will use the third concept of process (i.e., process as a series of steps).

The second critical issue is the range of research methods involved. Much has been written about the quantitative/deductive and qualitative/inductive research methods. There have been extensive debates about appropriate methodology for conducting research on process. For example, Inkpen (2000) objected to the use of simplistic process model on the dynamics of learning alliances by Khanna, Gulati, and Nohria (1998). In their response, Khanna, Gulati, and Nohria (2000) distinguished between ‘dirty hands’ and ‘clean models’— qualitative and quantitative approaches to modeling, respectively, and saw them as complementary rather than incompatible models in the examination of organization and management processes (Hirsch, Michaels, & Friedman, 1987). More specifically, they used an economic modeling (game theoretic) approach to racing behavior in learning within alliances. Khanna and colleagues (2000) claim that their model meets the requirements of a process and a content model. Apparently, these and other authors have varying concepts of the process (the first point raised above in this section), which may at least partially explain their differing points of view regarding the appropriate methodology for studying process. However, it may be helpful to understand ‘dirty hands’ models and make an attempt to ‘clean’ them in subsequent steps. At the same time, researchers may need to make the ‘clean’ models more sophisticated (Ofori-Danka and Julian, 2001).

In contrast to ‘clean models’ perspective, we follow a ‘dirty hands’ (or qualitative) approach (Hirsch, Michaels, and Friedman, 1987; Khanna et al., 2000) in this paper. We agree with Khanna and colleagues (2000) in general that ‘clean models’ (generated through quantitative research approach) and ‘dirty hands’ models (generated through messy, in-depth, qualitative studies) are complementary approaches. However, it is more important to match the phenomenon of interest with the relevant research methods. In this study, our focus will be on qualitative models due to the following reasons: a) we are interested in rich descriptions, analyses, and explanation of the process and its relation to content and context; b) there is considerable gap in the literature on reviewing these studies because they are complicated, time-consuming, and messy; c) it is important for the field to try to accumulate qualitative research because of its potential for generating insights that can later lead to ‘clean models’; and d) individual researchers don’t have the time and energy to review them but can use the cumulated findings to integrate with ‘clean models.’ In other words, the study of sustainable management and strategic processes is an area where messy, in-depth, and detailed qualitative studies can be particularly useful.

Before going into the details of current research and proposing models of strategic processes relevant for the theory and practice of sustainability, it may be useful to give background and overview of the study of strategic processes in organizations.
3. Strategic Process in Organizations

Over the years, several models of the strategy process and content have emerged. A reader of sustainability may already be aware of some of these schools such as SWOT (strengths, weaknesses, opportunities and threats) analysis, institutional theories, and stakeholder approaches that have been used in sustainable development in the past. Other schools though unfamiliar may provide stepping stones to understanding the role of strategic management for sustainability.

The classic models of strategic process may range from the Harvard Business School’s design (involving strengths, weaknesses, opportunities and threats (e.g., Andrews, 1971)), planning (e.g., Ansoff, 1965), industrial organization economics and positioning (e.g., Porter, 1980) to the cultural approaches (e.g., Peters and Waterman, 1982). These were followed by other approaches such as cognitive (e.g., Huff, 1990), learning (e.g., Crossan, Lane and White, 1999), emergent strategy (Mintzberg and Waters, 1985), configurational (Mintzberg and McHugh, 1985), and resources and capabilities (Barney, 1991; Wernerfelt, 1984; Hamel and Prahalad, 1994), among others. Several scholars have provided conceptual foundations and classification frameworks to organize the complex array of approaches (Chakravarthy and Doz, 1992; Chakravarthy, Mueller-Stewens, Lorange, and Lechner, 2002; Mazzola and Kellermanns, 2010; Olk, 2010; Pettigrew, 1992). For example, Scott (1998) categorized them into the rational, natural and open systems models and examined their interplay with one another (e.g., rational-natural systems). Similarly, Chakravarthy and White (2001) brought them together in a schema of four perspectives of rational, political, evolutionary and administrative.

Likewise, developing a broad framework, Mintzberg and his colleagues (Mintzberg, 1990; Mintzberg, Ahlstrand, and Lampel, 1998; Mintzberg and Lampel, 1999) organized them into ten process schools. The nine schools are as follows: design, planning, positioning, learning, cultural, environmental (including institutional and evolutionary approaches), political (including stakeholder and network perspectives), cognitive, and entrepreneurial. The tenth school is titled configurational, which may combine the other nine schools in a single process of management. Other scholars may differ on where and how a process school should be categorized. For example, Mintzberg and associates have used resource-based theory in terms of culture and learning, whereas others may categorize it as a part of economic or design schools. Nevertheless, this typology represents an outstanding and comprehensive framework from an academic point of view and provides a bird’s eye-view of strategic processes in organizations.

Interestingly, Mintzberg and associates (e.g., Mintzberg et al., 1998; Mintzberg and Lampel, 1999) have posed the question: Is it one process or different approaches. In other words, could these different processes co-exist in a single overall process or do they represent incompatible models? It is difficult to answer this question theoretically because organizations have consistencies as well as contradictions. Therefore, ‘how’ and ‘which’ of these schools are used simultaneously and under what conditions can only be observed in empirical studies. Moreover, the same mechanisms (or motors) may combine in different ways or the dynamics of different
combinations may vary from one another. In addition, the properties of these combinations may be vastly different from one another.

Reviewing empirical studies of the processes of development and change, including strategic processes, Van de Ven (1992) developed a taxonomy of four broad theories and argued that they used four motors: teleological, life cycle, evolutionary, and dialectical. Van de Ven and Poole (1995) further explicated these broad process theories and motors and showed how different theories represented illustrations of single-, bi-, tri-, and quad-motor theories as well as gaps in the literature. Garud and Van de Ven (2001) extended this agenda further and argued that in reality, these theories and motors were likely to combine in dynamic, even non-linear ways.

Austin and Bartunek (2003) complemented Van de Ven and Poole’s (1995) framework of four motors from change process theories with four motors of implementation theories used in practice: participation, self-reflection, action research, and narrative/rhetorical intervention. These frameworks can be helpful in exploring the evolving new models that examine rich descriptions of the strategic processes and may combine motors from academic as well as practitioner perspectives and their dynamic interactions.

4. Models of Strategic Process for Stability

In this section, we introduce models that specify the integrative role of strategic management. These models encompass varied, even conflicting factors such as intended and emergent strategies, structure and human agency, and individual and collective influences. They may have some overlapping mechanisms as well. A review of the literature on strategic processes leads us to believe that the following five broad, overlapping but distinct models have immense potential for sustainability in organizations in the future. Moreover, these models can be blended further to provide rigorous frameworks relevant for varying contexts to understand and guide research and practice for sustainability.

4.1 Guided Evolution

This model has its origins in Bower’s (1970) resource allocation model that focused on the teleological paradigm. Others who have made major contributions to the development of this model over the years include Bower (e.g., Bower and Doz, 1979; Noda and Bower, 1996) and Burgelman (1983, 1994). For instance, using the Bower-Burgelman model of iterative resource allocation at multiple levels, Noda and Bower (1996) analyze strategy-making processes leading to different courses of action at Bell South and US West corporations. Similarly, Smith and Zeithaml (1999) examine the strategy-making processes of international expansion at seven regional Bell operating companies. Likewise, Lovas and Ghoshal (2000) propose a guided evolutionary model in their study of Oticon, a Danish hearing aid company.

Winn and Angell (2000) propose four models for internal corporate greening process for environmental management—deliberate proactive, deliberate reactive, emerging active, and unrealized and examine each in a firm in consumer goods industry in Germany that are subject to

The guided evolutionary model emphasizes the interplay of academic- and practice-oriented motors—teleological (e.g., top management goals), ecological (variation-selection-retention; Lovas and Ghoshal, 2000), and participation (e.g., of middle and lower level managers in new product development in Intel, 3M, etc., Burgelman, 1983, 1984) and gives some consideration to other motors such as life cycle and action research as well.

4.2 Learning and Competencies

The learning and knowledge creation views have emerged from the writings of Argyris and Schon (1978), Brown and Duguid (1991), Crossan and associates (1999), Lave and Wenger (1999), Nonaka (1994), Polanyi (1966), and Senge (1990), among others. This model represents a combination of cognition, situated learning (Lave and Wenger, 1991), cognitive maps (Barr, Stimpert and Huff, 1992), dominant logic (Cote, Langley, and Pasquero, 1999; Prahalad and Bettis, 1986), and core competencies and rigidities (Hamel and Prahalad, 1994; Leonard-Barton, 1992). It may also incorporate strategic leadership (Denis, Langley, and Cazale, 1996; Denis, Lamothe, and Langley, 2001) and natural resource based view of the firm (Hart, 1995). In addition, it may include the dynamic capabilities model, which combines the design, evolutionary, and learning processes. It complements the more objectivist emphasis of the traditional models (Bower, 1970) and demographic studies of the upper echelons perspective (Hambrick and Mason, 1984) represented by the guided evolutionary model.

Several empirical studies document the use of this model in a variety of settings around the globe to develop and use their resources and capabilities, and to co-evolve their strategies and competencies over time. For example, Sharma and Vredenburg (1998) analyze the strategies and capabilities of the oil and gas companies in Canada for stakeholder integration, learning, and continuous improvement. Maritan (2001) employs a grounded process model in a Fortune 500 paper and pulp company to understand their varying capital investment processes for existing and new capabilities. Crossan and Berdrow (2003) investigate the multilevel process of learning and strategic renewal at Canada Post Corporation using the 4I model of intuiting, interpreting, integrating, and institutionalizing. Zietsma, Winn, Branzei, and Vertinsky (2002) also use the 4I learning model in their study of learning processes in a forest company in Canada that adopted sustainable forest management after years of resisting its stakeholder pressures.

Garud and Kumaraswamy (2005) explore the positive and negative roles of knowledge management using virtuous and vicious cycles in Infosys, a multinational computer software
company from India. Salmador and Bueno (2007) investigate the knowledge creation process using Nonaka’s mechanisms for socialization, explication, combination, and internalization in a virtual (Internet) banking company in Spain. Swart and Powell (2006) use qualitative system dynamics and knowledge mapping to study system based knowledge management using tacit and explicit knowledge in a professional accounting and financial services company in the United Kingdom (U.K.). Regnér (2003) combines an in-depth study of strategy creation in a Swedish company in the truck-trailer coupling using hydraulic systems with retrospective accounts in Ericsson, Pharmacia, and AGA to suggest that the managers at the periphery followed an inductive and exploratory approach, whereas executives at the center used a deductive and exploitative approach. Montealegre (2002) assesses the emergent process of capability development in an Ecuadorian stock exchange using resource based view of the firm regarding its electronic commerce strategy. Rindova and Kotha (2001) propose continuous morphing as a mechanism in their examination of transformations at Yahoo and Excite—two Internet firms using the concepts of dynamic capabilities and strategic flexibility. Keil, McGrath, and Tukiainen (2009) study the internal corporate ventures at a large European electronics manufacturer and report that the ventures co-evolved to contribute to develop and transfer capabilities in the firm.

In addition to the rational aspects of teleological motor and the evolutionary motor that it has common with the guided evolutionary model, the learning and competencies model explicitly calls attention to the more cognitive and enactment aspects of the teleological paradigm, self-reflections of the practice-oriented motors, as well as the dialectical motor (e.g., thesis-antithesis-synthesis) in management processes. One may speculate that whereas ecological motor (e.g., competition) receives more attention in studies within the United States, the dialectical motor (e.g., conflict) may attract more notice in other countries. In addition, scholars have noted the positive as well as negative perspectives of learning and competencies (Coopey, 1998; Driver, 2002; Leonard-Barton, 1992; Snell and Chak, 1998).

### 4.3 Institutional and Structuration

Several researchers use the institutional approach (DiMaggio and Powell, 1983) to examine strategic process in various organizations and industries. For example, Fox-Wolfgramm, Boal, and Hunt (1998) examine the incremental change processes in organization and strategic spheres for prospector and defender banks in the United States in response to institutional changes involving regulation using a grounded theory approach. Levy and Rothenberg (2002) analyze the divergent strategic responses of firms in the automobile industry (DaimlerChrysler, Ford, General Motors, and Volkswagen) regarding their environmental strategies in response to shifting perceptions of climate change in the institutional environments.

Structuration theory (Giddens, 1979) integrates the use of agency and structure rather than treating them separately. Pozzebon (2004) reviews several studies from 1995-2000 and concludes that concepts from the structuration theory have often been incorporated into other theories such as institutional theory. This model appears to be using some of the same motors as
the learning and competencies model though the interplay among them is conceptualized in more complex terms and in a recursive manner (Barley and Tolbert, 1997; Jarzabkowski and Wilson, 2002). Structuration theory and its variants may combine elements from decision making school and institutional theory (DeSanctis and Poole, 1994) and can help understand the development and use of technology in organizations (Orlikowski, 1992). Barley and Tolbert (1997) propose that studying institutionalization as structuration can bring rich insights. Windeler and Sydow (2001) in their study of project networks in television broadcasting in Germany assert that structuration theory can help understand the co-evolution of organizational form and industry by blending ideas from industrial organization and institutional theory. Using structuration theory, Heracleous and Barrett (2001) examine the conflicting and cooperative dynamics of various stakeholders’ communicative actions and deep structures in the failed implementation of electronic placing system at the London Insurance Market network. Jarzabkowski (2008) uses the structuration theory to examine strategizing behavior by top managers at three universities in the U.K. She concludes that both sequential and simultaneous approaches to shaping strategy are likely to be successful in weakly institutionalized environments, whereas the simultaneous approach is likely to be more successful in strongly institutionalized contexts.

Garud, Jain, and Kumaraswamy (2002) analyze institutional entrepreneurship at Sun Microsystems using structuration and coopetition as mechanisms in the emergence of Java as a technological standard. Likewise, using the case of a European non-governmental organization (NGO) working in Palestine, Lawrence, Hardy, and Phillips (2002) investigate how interorganizational collaboration through structuration can lead to proto-institutions. In a theoretical treatment, Hargrave and Van de Ven (2006) introduce a collective action model of institutional innovation based on insights from the technology innovation and the social movements literatures, viewing it as a dialectical process. The environmental movement can help institutional entrepreneurship in new green power generation opportunities and deinstitutionalize non-green alternatives (Hiatt, Sine, and Tolbert, 2009).

4.4 Complexity Theory

Similar to structuration theory, complexity and chaos theories are imported from other areas and are used more in organization theory than in strategy research. This model uses several motors including teleological, life cycle, evolutionary, action research, participation, self-reflection and narrative. However, the interactions among these motors seem to be modeled at a preliminary level. Based on increasing interest in the complex adaptive systems (e.g., Anderson, 1999), this framework appears to have an immense potential to model the sophisticated interactions in the future.

Though currently used in mostly simulation (e.g., Davis, Eisenhardt, and Bingham, 2009; Levy, 1994) and theoretical research (e.g., Cunha & Cunha, 2006) on a wide range of issues from strategic change (Stacey, 1995) to leadership (Uhl-Bien, Marion, and McKelvey, 2007) to project management (Aritua, Smith, and Bower, 2009), and a limited number of empirical studies, they are emerging as potentially useful and robust models for understanding strategic processes. For
example, Brown and Eisenhardt (1997) examine nine strategic business units of different firms in the U.S., Europe, and Asia where stability and unpredictability (e.g., in high velocity environments) give rise to self-organizing, probes into the future, and semi-structures to undertake continuous change. Eisenhardt and colleagues (Galunic and Eisenhardt, 2001; Helfat and Eisenhardt, 2004) in their studies of a Fortune 100 U.S. corporation in the high-technology field reveal how executives can use patching to restitch their modular divisions and capabilities over time in changing environments to build an organization as a dynamic community. Hundsnes and Meyer (2006) provide an example of Telenor—the Norwegian telecommunication company—on how it was organized and reorganized using the concept of patching. They argue that the firm had to deal with the paradoxes of centralization vs. decentralization, and similar vs. different patches. Too many different patches with centralization or too many similar patches with decentralization can lead to chaos, whereas too many different patches with decentralization or too many similar patches with centralization can lead to stability and inertia resulting into a lack of co-evolution. Thus, they argue that moderate levels of centralization-decentralization and relatedness (similar vs. different) are needed to be at the edge of chaos.

Van de Ven and Poole (1995), after reviewing process theories of organizational development and change, turn to their interplay and complex dynamics. Continuing with their journey in Garud and Van de Ven (2001), they remark, “While each of these types has its own internal logic, complexity and the potential for theoretical confusion arise from the interplay among different motors,” (p. 26) and focus their paper on complex non-linear dynamics, including increasing returns and other properties of complex adaptive systems. Similarly, in a special issue of *Organization Science*, Anderson (1999) describes the four well-known properties of complex adaptive systems: a) agents with schemata; b) self-organizing networks sustained by importing energy; c) co-evolution to the edge of chaos; and d) recombination and system evolution.

Using examples of two entrepreneurial firms, Lichtenstein (2000) examines the assumptions of complexity science and proposes a model of transformative change and development in complex adaptive systems. Likewise, MacIntosh and MacLean (1999) propose three-stage process of conditioned emergence—conditioning, creating far from equilibrium conditions, and managing the feedback processes—and illustrate with two examples of how it works in practice. Macbeth (2002) shows the application of a similar process in supply chain management. These processes can be particularly useful when environments are complex and unpredictable, for example, in new green power generation opportunities (Davis *et al.*, 2009). Boisot and Child (1999) propose two strategies for western firms to deal with complexity in the Chinese environment: complexity absorption and complexity reduction. In their study of hospitals in the U.S., Ashmos, Duchon, and McDaniel (2000) find that organizations that had the complexity absorption response as compared to complexity reduction response perform better in turbulent, complex environments. Similarly, in his study in South Africa, Mason (2007) reports that more successful firms in turbulent environments use radical, fast, and disruptive strategies using a bottom-up, adaptive, and emergent process. Finally, Houchin and MacLean (2005) in their four-year ethnographic study of a public-sector organization in the U.K. note the merits and limitations of the complexity theory, and suggest ways to improve it for application to management.
4.5 Critical and Postmodern

The critical and postmodern models seem to focus their attention away from the currently dominant teleological and ecological motors and more towards dialectical and narrative motors and their interaction, particularly in multinational and multicultural settings that call attention to diverse perspectives, discourses, and attempt at sense-making. These models take into consideration the role of self-reflection and participation motors as well. The models include theoretical (e.g., Alvesson and Deetz, 2006; Barry and Elmes, 1997; Knights and Morgan, 1991; Levy, Alvesson, and Willmott, 2003) as well as empirical work (e.g., Knights and Morgan, 1995; Laine and Vaara, 2007; Levy and Egan, 2003; Vaara, 2002). For instance, Levy and Egan (2003) investigate the corporate political strategies of conflict and accommodation by global climate coalition that represented about 40 U.S. companies and industry associations, which had major stakes in production and use of fossil fuels.

Several researchers examine varying roles of different types of discourses in organizations. For example, Hardy, Palmer, and Phillips (2000) show how discourse can be a strategic resource by illustrating the case of an individual to bring about change in an international NGO. Vaara (2002) reports that the rationalistic discourse is used as the dominant discourse, whereas cultural, role-bound, and individualistic discourses act as alternatives to construct success and failure in narratives of post-merger integration in eight Finnish-Swedish mergers and acquisitions. Maitlis and Lawrence (2003) analyze the failure of strategizing at a British symphony orchestra due to discourse and politics. Using the discourse perspective in an ethnographic study of building a manufacturing facility in a firm, Samra-Fredericks (2003) documents how strategists become effective in everyday conversation about strategy. Laine and Vaara (2007) examine strategic development from the top, middle, and lower levels using a critical discourse perspective to reveal the dialectical struggle between control and resistance in an engineering and consulting firm in Northern Europe. In their study of 12 professional services organizations in Finland and other Nordic countries, Mantere and Vaara (2008) investigate discourses that promote and impede participation in strategic practices in organizations. Balogun, Jarzabkowski, and Vaara (2011) study the role of three discourses—selling, resistance, and reconciliation—in the political dynamics and evolution of parent-subsidiary relationships in multinational enterprises.

4.6 Blending the Models

There may be other models or their composites that could be used in an examination of strategic processes in sustainable management. For example, Weick’s (1979) sense-making can be used by itself or in combination with other models. Similarly, Bogner and Barr (2000) propose an adaptive sensemaking process, which can explain the institutionalization of hypercompetitive mindset in firms and industries such as digital telecommunication. In fact, there is a realization that the “neatness” of the strategic process typology (Mintzberg, 1990) is being “messed up” due to overlaps across different schools (Mintzberg and Lampel, 1999). Researchers are consciously integrating different process schools and are building linkages across in order to make sense of the reality of the organizations around them. As a result, a number of newer models have
emerged. For example, in their study of the regional Bell operating companies’ diversification to the cellular phone industry, Noda and Collis (2001) propose a model of evolution of intra-industry firm heterogeneity based on a firm’s initial experience in its local market, divergent forces such as local learning and positive feedback, and convergence forces such as global learning. Likewise, varying combinations of learning, knowledge, capabilities, power and institutionalization (e.g., Fox, 2000; Kellogg, Orlikowski, and Yates, 2006; Lawrence, Mauws, Dyck, and Kleyesen, 2003) are evolving, which have the potential for a more integrated, fine-grain analysis. In their several studies, Vaara and colleagues investigate the dynamics of legitimation and delegitimation related to strategic and structural changes using the recursive perspective of discourse and action (e.g., Vaara and Monin, 2010; Vaara and Tienari, 2011; Erkama and Vaara, 2010).

Marcus and Geffen (1998) propose that the passing of Clean Air Act 1990 in the U.S.—the role of the government for institutional change as teleology and competing electric utilities in the market as evolutionary. Using a dialectical lens, they posit the former as thesis and the latter as antithesis, and integrate them to bring a synthesis. The authors’ focus is on competency acquisition by electric utilities to manage their physical environment for pollution control. The utilities essentially used the solutions brought to them by their technology suppliers. These authors seem to blend various perspectives such as the guided evolution, the learning and competencies, the institutional, and the dialectical perspectives. Likewise, Fudge (2010) uses the teleological, evolutionary, and dialectical motors to understand the mechanisms involved in the termination of a telecommunications companies’ strategic alliance in Canada.

Further, a number of studies on sustainability use the political ecology approach (e.g., Brogden and Greenberg, 2003; Dove, 2003; Paulson, Gezon, and Watts, 2003) that brings together ideas from ecology, power and politics, as well as complexity and emergence. Others propose a community-based approach (e.g., Natcher and Hickey, 2002). In other words, the boundaries of management models are blurring resulting into further extension across levels of analysis. Mintzberg and Lampel (1999) use the analogy of an old tree where branches get tangled over time rather than the extinction of the species as would be expected in biological evolution.

It is worth noting that researchers are making attempts to develop multilevel theories and models of organizational phenomena. For example, Bettis and Prahalad (1995) while extending their previous work on dominant logic, theorize dominant logic as an emergent property of complex systems seeking to adapt. Integrating the concept of dominant logic with learning, unlearning and evolutionary dynamics, they argue that the dominant logic may, in turn, influence the subsequent movements in the organizational landscape as well as industry equilibrium or disequilibrium.

Aldrich and Ruef (2004) develop the process of variation-selection-retention-struggle, an evolutionary theory as “an overarching framework with a set of concatenated principles. Applied across multiple levels of analysis, it is open to multiple approaches for explaining particular kinds of changes” (p. 72). They, specifically, recognize six approaches, namely, ecological, institutional, interpretive, organizational learning, resource dependence, and transaction cost
economics, to draw upon to construct evolutionary explanations. They also discuss how each approach conceptualizes the process of variation-selection-retention-struggle-transformation and has implications for the evolutionary paradigm.

It is clear from the above that the models that we have presented here have the potential of further integration. Therefore, following Aldrich and Ruef (2004), we argue that they could be variously combined into an overarching framework. However, this framework may go beyond evolutionary ideas. It is important to keep in mind that we are not looking for a hegemonic model, but a plurality of approaches that may be available to support the researchers’ as well as practitioners’ minds in the future.

The variance of strategic process models pointed out above by Garud and Van de Ven (2001) is expected to provide requisite variety according to Ashby’s law (Weick, 1979) so researchers can enrich their conceptual repertoire to guide future research and generate interesting theoretical insights on strategic processes for sustainability. These models have contributed to a more clear understanding of organizational realities for researchers as well as students of management. A future integration of the models derived in this study in the future may help researchers examine complex strategic processes in particular settings of sustainability in organizations and can guide further research. The expectation is not that the future will be a duplication of the past, but a more sophisticated conceptualization may help researchers and practitioners make sense of the future leading to rigorous theory and thoughtful practice on sustainability in organizations.

We hope, this chapter will help sustainability researchers to see the bigger picture and better appreciate the dilemmas of using different models, which can integrate multiple, even conflicting perspectives to deal with the ‘wicked’ problems that theorists as well as practitioners face. As Mintzberg and Lampel (1999) assert, “We must give more attention to the entire elephant …. We may not see it fully, but we will see it better” (p. 29).

5. Conclusion

The objective of this chapter is to explore the integrative role of strategic management for sustainability through strategic process models. A survey of strategic process research provides five broad overlapping, but distinct models that have the potential for use in the future: Guided evolution, learning and competencies, institutional and structuration, complexity theory, and critical and postmodern models. As sustainability researchers better understand these models, they are likely to generate potentially useful theory and empirical research. Our analysis reveals that strategic process researchers in general are in the fore-front of integrating academic-oriented perspectives and practitioner-oriented perspectives (Austin and Bartunek, 2003). For example, in addition to the teleological, life-cycle, and evolutionary motors, strategic process researchers are using motors such as participation, self-reflection, dialectical and narrative as well. In particular, cognitive, evolutionary, dialectical, and narrative motors are often being used with other mechanisms in the analysis of strategic processes, which may be emulated in sustainability research in organizations. Furthermore, extending the notion of action research as a practice-oriented motor mostly used in organizational development (Austin and Bartunek, 2003), there
may be support for using networking as a motor for strategic processes for sustainability. Networks and alliances have been the dominant theme in strategy research in the 1990s. However, they have mainly been thought so far in terms of content rather than process.

Finally, this paper may help sustainability researchers realize the big picture so they can consciously combine explanations from several models rather than act as “six blind men of Indostan” focusing on the parts and missing the beast. Also, it is useful in arriving at the five alternative archetypes in answering the important question of how and which strategic processes combine in practice, which can be further blended into various models in the future.

Further work extending it to other studies in various settings and international locations would strengthen the findings of this effort. Management researchers are increasingly appreciating the diversity of international settings in terms of economies, cultures, societies, and organizations. Future attempts to include studies from Scandanavia, Eastern Europe, Asia, Africa, South America and other settings are likely to provide further dividends to development of better theory at home and abroad.

To conclude, we explore the role of strategic management for sustainability through strategic process models used in qualitative approach. The five broad overlapping but distinct models proposed in this study document how various factors such as economic-rational, behavioral, cognitive, social, cultural, political, technological, and other influences work thorough various processes to induce pressures for and against change in diverse ways in varied settings. These models of strategic processes are likely to enrich the horizons of sustainability research for building actionable knowledge and knowledgeable practice in the future.

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1. Taxation Policy: Theoretical Underpinnings

The prime objectives of tax policy are growth, distribution and stabilization. The major concern is growth and also it is important to analyze the effects of tax policy on distribution and stabilization in an economy. The most important “growth” objective for tax policy is to provide the resources needed for public sector capital formation and other necessary expenditures to supplement development activities including for poverty reduction. The conventional strategy for additional revenue mobilization by inducting interventionist approach, and thereby raising rates for all individuals taxes have been abandoned with the emergence of globalization and liberalization in developing economies (Dahal, 2009). In recent years, both advanced and developing economies have adhered to reductionist approach to resource mobilization and thereby attaining the growth objectives, and so is the case in Nepal.

In recent years, tax effort ratio (TFR) has moderately increased in Nepal with lowering down of tax rates as of WTO, SAFTA and BIMS-TEC provisions. The average growth rate of revenue has remained impressive, which went up by 22.6 percent in FY 2010/11 while compared with previous year. The revenue-GDP ratio is estimated to be 15.3 percent, which is yet one of the lowest in the SAARC region. The Three-Year Interim Development Plan (TYIDP), 2010-12 (TYDP, 2010) has envisaged that revenue-GDP ratio would level to 16.0 percent of GDP, while the Tenth Plan (2002-2007) had the target that number of income taxpayers would reach 300,000 and number of taxpayers registered under VAT would be 40,000 (Tenth Plan, 2002). Unfortunately, the current TYIDP has no reference to quantitative targets for VAT, Customs and Excise Duties, and income tax.

Past experiences suggest that revenue could be mobilized on a greater scale by reducing tax rates in conformity with the guidelines set by WTO, SAFTA and BIMS-TEC provisions. The additional revenues could be generated without creating additional burden to taxpayers by expanding legal base, identifying new tax imposts, and improving efficiency of tax administration, increasing voluntary compliance and restraining leakages attributing to corruption. In the past government occasionally called for voluntary disclosure of income for additional revenue mobilization, which is self-declaration of income and payment of tax according to existing rates without disclosing sources of income. However, there is apprehension that revenue derived from customs duties may decline after 2017 in Nepal resulting to increasing
size of fiscal and budget deficits. The expected revenue deficit due to decline in revenue from import duties could be off-set through mobilizing additional revenue from VAT.

This is a matter of great debate whether tax burden is high or low in Nepal. Two arguments can be put forward: (a) tax burden is high considering per capita income criterion, and (b) tax burden is low employing elasticity of taxation criterion. In many economies with high per capita income (> US$ 1,000), tax effort ratio (TER) is below 18.0 percent, while Nepal with US$ 645 GNI per capita income tax effort ratio is estimated to be 15.3 percent of GDP. For example, in India, Pakistan, Sri Lanka, Thailand and Philippines tax burden was found to be below 16.0 percent of GDP in 2008, where GNI per capita income in these countries were found to be many a times higher than Nepal. Thus, tax burden is high in Nepal employing GNI per capita criterion. On the contrary, elasticity of overall taxation is found to be below unity and, therefore tax burden is low. This calls for improving tax system through reforms in taxation. The tax system is said to be perfect where revenue can be mobilized without adjusting discretionary changes to upward direction comprised of increasing tax rates and expanding tax base, and without creating excess burden to the taxpayers. Distribution and stabilization aspects can play effective role in reducing income equalities and price level and balance of payments stability.

2. Agriculture Taxation

Nepal is primarily an agrarian economy and agriculture is the main stay of life. The available data reveal that more than 74 percent of total population still derive their livelihood directly from agriculture and its contribution to GDP is as high as 33 percent as of 2010 (WDR, 2012). However, taxing agriculture sector in Nepal is not only challenging but also the most sensitive proposition, for it is a subsistence informal sector encapsulated by low productivity, disguised unemployment, and increasing rural indebtedness with acute and pervasive poverty.

The major challenge facing agriculture sector is how to transfer excessively dependent population from agriculture to more productive non-agriculture sector by creating employment opportunities and thereby reducing the extent of poverty, which is known as the process of economic transformation. Subsequently, the other crucial issue associated with agriculture is how to achieve a moderately fair and inclusive growth through commercialization and modernization of agriculture by mobilizing adequate investments to increase production and productivity of both food and cash crops (high value crops).

Although agriculture is a priority sector envisaged by the government in existing 3-Year Interim Development Plan (TYIDP), 2010/11-12/13, resource allocations to this sector is minimal estimated to be 3.2 percent of total expenditures, and 0.88 percent of GDP (Budget Speech, 2011). The private sector spending on agriculture sector is also inordinately low against the ambitious projection of TYIDP (13 percent of total investment), which is attributed to high cost of production and poor return on investment. More recently, Nepal Rastra Bank (NRB), the Central Bank of Nepal has also modulated its monetary policy for FY 2011/12 in conformity with the objective set by the government to accord a top most priority to agriculture and
accordingly directed all commercial banks to step up the size of credit portfolio to agriculture sector from 3 percent to 5 percent of total flow of investment (NRB, 2011).

Despite a series of package of enormous subsidies regularly provided to all-time infant agriculture sector, its performance is dismal due to conspicuously low level of existing competitiveness to match with quality and prices of agricultural products imported from India with open border, inadequate subsidies below the level of what is currently provided in India on fertilizer, petro-products, irrigation, electricity, and interest on loan especially taken by small farmers, fragmentation of holdings due to existing social system, and lack of a scientific land reforms system to increase productivity for bumper production and address the issue of poverty alleviation.

The income from agriculture is exempted from taxation and the contribution of land tax to total revenue and GDP is extremely low and almost negligible, which is collected by local authorities at VDCs and municipalities. In addition, the revenue assignments to local authorities envisaged in the Local-self Governance Act 1999 provide considerable amount of resources from the impost Land and House Registration fees through sharing with the centre (LSGA 1999).

Although legal base of agriculture taxation is extremely limited with blanket exemptions to income from agriculture, internal resources could be mobilized through taxing agriculture as a mass taxation with modernization and commercialization of agriculture and through implementation of a scientific land reforms system by developing national consensus among major political powers. The commandments of major political parties contesting election of Constituent Assembly (CA) in April 2006 favored to further lowering down of land ceiling with distribution of surplus land to landless instrumental for poverty reduction. However, the impact of classical approach to land reforms program on productivity in the past was neutral and indifferent to raising productivity with social system leading to fragmentation of holdings creating distortion in the society (Election Manifesto of Political Parties, 2006).

The efforts towards commercialization of agriculture in recent times at the initiation of Agro Enterprise Center (AEC) at FNCCI, a private sector apex body would certainly help strengthening agribusiness and establishing Small and Medium Enterprises (SMEs) ensuring tax potential in agriculture sector. During the last several plan periods respective governments were totally indifferent to taxing agriculture sector primarily attributing to political reason that local leaders were afraid of implementing house and land tax and process towards introducing integrated tax in municipal areas is at snail’s speed and confined to a very few municipalities. Although collection of revenue from house and land tax is minimal at present as of LSGA 1999, there is tremendous scope for revenue mobilization on a greater scale from agriculture sector with implementation of commercialization and modernization of agriculture to promote agribusiness and income generating activities among rural poor.

3. Specific Vision
The specific vision for tax policy should be to mobilize additional resources from agriculture sector as a mass taxation by taxing all income from agriculture above exemption limit without creating excess burden to taxpayers in the long run through improving competitiveness and productivity of agriculture with induction of appropriate technology and in cooperation with private sector to promote agribusiness by moving towards commercialization and modernization of agriculture. This requires expanding legal base for agriculture taxation by gradually removing too many tax shelters and also reviewing the existing provisions for subsidies provided to agriculture sector. There is also need to review and amend the existing Acts and Regulations relating to agriculture and land reforms (see appendix 1).

4. Overall Vision

The overall vision of agriculture sector consists of: “a competitive, sustainable and inclusive agriculture that contributes to economic growth, improved livelihoods, and food and nutrition security” (Vision Workshop, November 30, 2011).

Similarly, the vision for tax policy to attain the overall vision of agriculture sector should be: to generate additional resources from agriculture sector as a mass taxation with increase in AGDP (GDP available from agriculture) by taxing income above exemption limit without creating excess burden to taxpayers and through increasing competitiveness and productivity with induction of appropriate technology through commercialization and modernization of agriculture during the next 15 years from 2015 to 2030.

5. Identification of Tax Policy Options

The time-frame for implementation of tax policy option should be phase-wise comprising - Phase I: 2015-20; Phase II: 2020-25; and Phase III: 2025-30.

Phase I: Transition (2015-20):

Review of Acts and Regulations: in which LSGA 1999 should be extensively reviewed especially with reference to agriculture and land reforms related Acts and Regulations and adjusted to necessary amendments ensuring a pragmatic and feasible revenue assignments to all local authorities and the Center to mobilize resources through: (a) own revenue sources, (b) revenue sharing, (c) internal and external borrowings, and (d) grants and assistance from the Center to local bodies.

Classification of land: During transition Department of Land Revenue (DoLR) should launch a fresh scientific land survey in order to prepare a consolidated record of land. It is extremely important to conduct a new cadastral survey to scientifically classify the land according to its use and exchange value throughout the country. The survey will facilitate to help identify the existing status of land, for example: farm and non-farms, rural and urban, cultivated and barren, small and large estate farming, residential and commercial/business category land etc.
Updating of Land Record and Consolidated Record of Property (house and land): During the initial phase there is need for updating record of consolidated property (house and land) of individuals and households throughout the country. The Department of Land Revenue suffers from the lack of record of entitlement, transfer and division of land, whereas the VDCs and the municipalities have no record of land ownership and database for revenue collection. Although family disputes are attributed to property in Nepal, land is not only a perennial source of resources, power and status but also people have a great sentimental attachment to it. Land has high credit rating and is accepted as effective and reliable collateral for borrowing from the banks and financial institutions. Unfortunately, the government has no consolidated record of property of land and house of an individual or family within Nepal. The Department of Land Revenue should launch a fresh scientific land survey in order to prepare a consolidated record of land.

Review of Existing Status of Land Reforms Program and the proposal for Launching of a New Scientific Land Reforms Program: The existing land reforms program should be reviewed and also it is essential to introduce a scientific land reforms program associated with the concept of raising productivity of agriculture sector comprising both food and cash crops and poverty reduction through Green Revolution. In the past Commissions for land reforms programs were constituted but with no existence to implement the recommendations. The context of land reforms program capsized under the dungeon of federalism in Nepal, which is a prime factor why constitution making is delayed and at present not at sight. It would not be pragmatic approach to taxing agriculture sector without improving land system by inducting a scientific land reforms program to ensure increase in production and productivity of agriculture.

Modulating Social System to Regulate Fragmentation of Holdings: During the transition phase it is also important to modulate the social system to regulate fragmentation of holdings through division of property among the heirs, which has adversely affected productivity of agriculture and jeopardize the possibility of mechanization to speed up the process for commercialization and modernization of agriculture.

Reviewing the Package of Subsidies and Other Incentives: There is need to review the existing package of subsidies, incentives and exemptions provisioned by the government for agriculture sector and it is pragmatic to providing targeted subsidies and incentives in place of blanket exemptions. The Government has announced a series of programs and policies to foster agriculture development in Nepal (Budget, FY 2010/11). The list includes: (a) provision for subsidy to establish laboratory, pesticide, seeds production and packing; (b) encouragement to land pooling system for effective mechanization of agriculture; (c) exemption for imports of agriculture tools; (d) support to irrigation; (e) subsidies on fertilizers and seeds; (f) encouragement for the use of organic and compost fertilizers; (g) provision for credit facility at concessional interest rate through small farmers cooperative institutions to the people involved in livestock, poultry and fish-farming; (h) 50% subsidy on premium of crops and livestock insurance; (i) 50% subsidy on the capital expenditure to the small farmers cooperative institutions in the purchase of machinery and equipment for processing cardamom, tea, coffee,
ginger, nut and honey; (j) subsidy will be provided on electricity tariff and interest on credit to the cooperative and private sector if they operate cold storage by constructing more than stipulated capacity; (k) affordable credit will be made available to the farmers for commercial agriculture; and (l) effective implementation of “One Village One Product”.

**VAT Instrumental to Compensate the Revenue foregone Attributed to Subsidies:** At this critical juncture, there is no alternative to VAT for supplementing required amount of subsidies provided to agriculture sector. However, subsidies provided to other than agriculture sector must be gradually withdrawn. In this context, the report submitted on Multi-VAT rate (Dahal, 2009) to Ministry of Finance/Government of Nepal refers to the possibility of mobilizing additional revenues to match the size of subsidies to some extent.

**Valuation of Property:** Upon completion of classification of land and after accomplishing consolidated record of property especially house and land, the next step would be to take care of valuation of property with access to infrastructure employing market price through a certified valuator approved by the government. The valuation should be continuously done after the interval of every five-year to adjust with market prices.

**Determination of Tax Rates:** Thereafter, the local authorities should determine the tax rates with the approval from Local Council at VDCs and municipalities. The Ministry of Local Development/GON should assign full authority to local bodies to independently assess the value of land through a chartered valuator and determine the tax rates. The tax rates on house and land tax may differ from each local body to other depending on the extent of development in VDCs and municipalities.

**Horizontal vs. Vertical Tax Rates:** A tax policy with different tax rates should be enforced in the context of property (land and house) in terai, hills and mountains, and also a separate tax rates should be introduced for improved rural and urban areas especially in VDCs, Municipalities. A vertical tax rate should be levied on improved urban house and land with increase in income and horizontal tax rates should be applied for property under rural settings. A nominal rate should be applicable to cultivated rural land possessed by small farmers and a progressive rate should be levied on residential and commercial/business site separately in rural and urban areas.

**Developing Hill-Township and Local and Regional Market Centers- Expanding the Base of Agriculture Taxation:** The local authorities should make an effort to developing hill –township in hills and mountains and promoting local and regional market centers in terai areas. The marketing centers must have access to road to connect villages with other facilities such as roof-shade with corrugated sheet, drinking water, electricity, drainage, toilet, telephone, transport and security. This will provide substantial resources from fees and charges against the facilities provided to marketing centers.

**Method of Assessing Tax on Agriculture Land:** Considering the existing vulnerabilities and poor competitiveness in agriculture sector in Nepal it is essential to continue and strengthen existing land tax but with upward revision of tax rates during the first phase of transition within next five
years between the period 2015 and 2020. This should continue as long as commercialization and modernization of agriculture through agri-business does not effectively take place in cooperation with private sector. The three methods could be applied for assessing tax on agriculture land: (a) tax based on land area (property); (b) tax based on market value or net income of land; and (c) tax based on objectives measures which are proxies for land productivity or potential income of land.

**Strengthening House and Land Registration Duties:** It is also significant to continue and strengthen existing provision for registration duties levied on the sale and purchase of property (house and land) with incidence of taxation on the new ownership. However, the center should relax from its prerogative to collect registration duties and transfer the authority to local bodies to collect revenue available from registration duties without sharing with the center and earmark the expenditure on priority.

**Strengthening Revenue Administration:** The local authorities are required to: (a) improve capacity of revenue administration by employing efficient staff and providing them appropriate in-service training (b) improve capacity of internal auditors to manage the audit function through qualified staff by providing them appropriate training (c) develop a sound database for land ownership and revenue collection from different sources as specified in the LSGA 1999 (c) establish either a separate revenue section or jointly with account section.

**The Role of the Private sector:** The donors, government and the private sector should work in tandem to expedite the efforts toward improving tax system in Nepal. Since the capacity of both national and local taxation authorities are limited to effectively mobilize resources, the priority of the government should be to improve the efficiency of revenue administration. The prime stakeholders such as FNCCI and the Chamber of Commerce can play a significant role in developing a sound taxation policy and formulate an appropriate strategy to eliminate arbitrary assessment of taxation that has not only distorted the tax system but also the people have lost its confidence that taxation is the function of the economic development.

**Phase II: Consolidation (2020-25)**

**Implementation of Integrated Property Tax (IPT):** In recent years, a few municipalities have introduced “Integrated Property Tax (IPT)” in lieu of House and Land Tax as envisaged in LSGA 1999 but with partial success. Although IPT has the great merit to generate substantial yield, a large number of municipalities are unable to implement IPT due to administrative and political constraints at the local levels. Therefore, it is extremely important to effectively implement IPT during the consolidation phase II (2020-2025) in all municipalities, which would not only substitute existing house and land tax but also supplement tremendous revenue to local bodies. However, a successful implementation of IPT by all municipalities is conditioned to strong commitment of local political leadership and efficient tax administration with updated record of house and land for each household. This requires to identifying the each house built within the jurisdiction of municipalities and provide house number to all houses.
Introducing Capital Gain Tax: The Capital Gain tax especially with reference to sale and purchase of urban house and land could be considered during the second phase of consolidation with the process of urbanization and development of infrastructure especially within municipal areas and relatively developed rural areas. Integrated property Tax (IPT) will be annually levied based on the value of property preferably corresponding to market price or the rate as decided by the local bodies, while capital gain tax would be charged during the sale and purchase of property based on present value employing the rates determined by the local bodies comprising VDCs and municipalities.

Introducing Inheritance Tax: It is necessary to introduce inheritance tax on transfer of property after the demise of the owner, which would be instrumental to yield substantial amount of revenue from property comprising house and land.

Phase III: Expansion (2025-30)

A Partial Withdrawal of Subsidies: During the phase III (2025-30) of expansion with the process of commercialization and modernization of agriculture it would be realistic to assess further the need for subsidies and gradually withdraw from areas with improving competitiveness and retain targeted subsidies. However, it depends on the extent of subsidies provided by India to its farmers on different areas.

Improving Competitiveness at Par with India: There is need to formulate vision, tax policies, and strategies for revenue mobilization in agriculture sector through improving competitiveness preferably at par with India.

6. Advantages and Disadvantages of Options

Merit of House and Land Tax: It is necessary to implement house and land tax at the initial stage by abolishing traditional land tax, which is perennial source of revenue and easy to collect but with extremely insignificant contribution to total revenue mobilization at local levels. As envisaged in LSGA 1999 the house and land tax has the great merit to generate substantial yield levied on the value of property without creating additional burden to taxpayers. The disadvantage of existing traditional land tax is that its contribution to total revenue is minimal with a series of exemptions and deductions and politically motivated delinquency is very high.

Superiority of Integrated Property Tax (IPT): With successful implementation of house and land tax for a few years and with full groundwork preparation it is essential to switch over to Integrated Property Tax (IPT), which is particularly known as ‘one-window’ tax based on scientific assessment of property that would substitute all kinds of property taxes in future. The IPT has the merit to be always buoyant that would yield substantial revenue instrumental in meeting adequacy requirements of local bodies. The only disadvantage associated with implementation of IPT is that a majority of VDCs and municipalities are incompetent to prepare the updated record of consolidated property attributing to poor administration and politically motivated indifferent attitude of local authorities.
Importance of Capital Gain tax: As the process of urbanization advances with economic development in an economy, the contribution of capital gain tax would increase through expansion in real-estates and by taxing income from transaction of property there would be scope for introducing capital gain tax.

Challenge to Taxing Income from agriculture: Although agriculture sector is the biggest but subsistence sector, it is extremely challenging to tax income from agriculture above the exemption limit. Income from agriculture is fully exempted and a considerable package of subsidies is provided to farmers to encourage production and productivity in India. Similarly, the proposal for taxing income from agriculture would be a difficult choice in Nepal with low productivity, traditional agrarian system, and poor irrigation facilities.

7. Preferred Option and Justification for Recommendations

The priority should be to strengthen house and land tax by abolishing traditional land tax and also strengthen registration duties without sharing with the center at the initial stage. And, thereafter, it is pragmatic to implement Integrated Property Tax (IPT) during the second phase by replacing all other property taxes. Capital gain tax and inheritance tax be levied to mobilize resources at local levels in the long run. Taxing agriculture income and withdrawal of subsidies not feasible during the transition and consolidation phases, for economic and political conditions are very fluid and volatile. These are subject to India’s policy towards taxing income from agriculture with withdrawal of subsidies provided to farmers. The concept of fiscal federalism suggests for providing more avenues for revenue mobilization to local authorities through devolution of economic powers from center to local bodies.

8. Combined Set of Preferred Options

It would be better to continue with strengthening house and land tax and also registration duties during the transition phase (2015-2020) and move towards inducting Integrated Property Tax (IPT) by replacing house and land tax at the end of transition and with the beginning of consolidation phase.

9. Conclusion

Agriculture is not only the biggest but also a top priority sector in Nepal. However, it is a subsistence sector and, therefore, agriculture is outside the jurisdiction of taxation. Theory also suggests that tax should be levied on surplus and not on subsistence. Although government is campaigning for commercialization of agriculture through Budget and Plan Documents over the years, the social laws promote fragmentation of holdings detrimental to implement large-scale farming. And, under the circumstances, it is virtually impossible to move towards Green Revolution through mechanization. Land ceiling has not been instrumental to raising productivity of agriculture. The major problem of agriculture sector in Nepal is that there is no adequate incentive provided to this sector at par with what India is providing to its farmers to match the quality and prices. It is, therefore, important that reforms in agriculture sector should
follow phase-wise as mentioned above under: (1) Transition Phase (2015-20); (2) Phase of Consolidation (2020-25); and (3) Phase of Expansion (2025-30). The agriculture sector must improve its productivity and move towards implementing commercialization of agriculture through agro-enterprises and with adjustments to pertaining Acts and Regulations. Unless agriculture sector would produce surplus through commercialization, incentives particularly subsidies should continue and agriculture should be free from taxation. Nepali households have emotional attachment to land, which is a symbol of pride and prestige in Nepali society and it is also the important asset and collateral for banking and business transactions.

Appendices

Appendix 1: Existing Acts and Regulations relating to Agriculture and Land Reforms


Appendix 2: Vision and Mission of AEC/FNCCI

Agro Enterprise Center (AEC), the agricultural wing of the Federation of Nepalese Chambers of Commerce and industry (FNCCI) was established in September 1991 under the Cooperative Agreement between FNCCI and USAID/Nepal. Within past fifteen years, FNCCI/AEC made valuable contributions in Agro Business Development and Promotion. Since 01 October 2002, FNCCI/AEC has been re-shaped with more focused Mission and Vision and is taking a renewed role in re-presenting the private sector agribusiness community in the development of agriculture and agribusiness in Nepal.

Vision: "The vision of FNCCI/AEC in the national context is to be a strong, vibrant and sustainable private sector led agro-enterprise sector capable of contributing high and broad based economic growth".

Mission: "To expand and strengthen market oriented private sector driven agro enterprises in order to increase the value and volume of high-value products old domestically and internationally" (www.aec.fnnci.org).

Appendix 3: Alternative Methods to Resource Mobilization in Developing Countries

(1) Revenue sharing with Provincial and the Central Government.
(2) Mobilizing resources through “Matching Fund” at the support and guarantee of Central Government.
(3) Introducing “Equalization Fund Scheme” especially to attain same level of services in backward areas as compared to advanced areas in PS.
(4) Allocating block grant to local bodies by Central Government in its annual budget approved by the Parliament.
(5) Mobilizing savings from households receiving remittances especially in the context of income generating activities and poverty alleviation.
(6) Developing economically viable projects under public-private partnership with investment loan from commercial banks and lending agencies including foreign funding agencies.
(7) Setting up of a “Local Development Fund”.

Appendix 4:

Revenue Assignment as of LSGA, 1999
- Inter-government fiscal transfer and amount received from revenue sharing (Unconditional grants to DDCs: HDI 505; Area 105; Population 205; and Cost index 205)
- Internal revenue received from tax and non-tax sources
- Internal and external borrowings
- Miscellaneous sources including the programs supported by donors.

Revenues to DDCs through Revenue Sharing
- 5-90% of revenue collected from house and land registration
- 50% of royalties received from mines
- 40% of fees collected from tourists
- 10% of royalties received from forest products
50% of royalties received from hydropower. Of which DDC located at hydro-plant area will receive 12% of the amount received by DDC, and other districts within the development region where hydro-plant is located will receive 38%.

25% of Malpot (annual fee against entitlement/ownership of land) collected by VDCs and Municipalities

45-50% of total collection of DDCs from the sale of sand, stone, slate, and gitti etc should be provided to concerned VDCs and Municipalities

Revenues to Municipalities

- Grants from the government
- Grants from DDCs
- Grants from TDF
- Internal sources
- Local development tax (75-80% of total revenue including all grants). LDT is collected at Customs points at the rate of 1.5% of import duties.

Structure of Income in VDCs

- Grants from the government
- Grants from DDCs
- Other grants
- Internal sources

Appendix 5: Tax Structure in Selected Countries, 2008

<table>
<thead>
<tr>
<th>Countries</th>
<th>GNI Per Capita</th>
<th>Tax revenue as % of GDP</th>
<th>Income Tax Rate %</th>
<th>Corporate Tax Rate %</th>
<th>Sales/VAT Rate %</th>
</tr>
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<tbody>
<tr>
<td>Argentina</td>
<td>7,200</td>
<td>22.9</td>
<td>35</td>
<td>35</td>
<td>21</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>5,200</td>
<td>8.5</td>
<td>25</td>
<td>27.5</td>
<td>15</td>
</tr>
<tr>
<td>Bosnia Herzegovina</td>
<td>4,510</td>
<td>41.2</td>
<td>10</td>
<td>10</td>
<td>17</td>
</tr>
<tr>
<td>Brazil</td>
<td>7,350</td>
<td>38.8</td>
<td>27.5</td>
<td>25</td>
<td>20</td>
</tr>
<tr>
<td>Cambodia</td>
<td>600</td>
<td>8.0</td>
<td>20</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>China</td>
<td>2,940</td>
<td>17.0</td>
<td>45</td>
<td>25</td>
<td>17</td>
</tr>
<tr>
<td>Denmark</td>
<td>59,130</td>
<td>48.9</td>
<td>51.5</td>
<td>25</td>
<td>25</td>
</tr>
<tr>
<td>Egypt</td>
<td>1,800</td>
<td>15.8</td>
<td>20</td>
<td>20</td>
<td>10</td>
</tr>
<tr>
<td>Germany</td>
<td>42,440</td>
<td>36.2</td>
<td>42</td>
<td>33.3</td>
<td>19</td>
</tr>
<tr>
<td>India</td>
<td>1,070</td>
<td>17.7</td>
<td>30.9</td>
<td>33.9</td>
<td>12.5</td>
</tr>
<tr>
<td>Japan</td>
<td>38,210</td>
<td>27.4</td>
<td>40</td>
<td>40.8</td>
<td>5</td>
</tr>
<tr>
<td>Malaysia</td>
<td>6,970</td>
<td>15.5</td>
<td>26</td>
<td>25</td>
<td>5-10</td>
</tr>
<tr>
<td>Nepal</td>
<td>400</td>
<td>10.9</td>
<td>25</td>
<td>20-30</td>
<td>13</td>
</tr>
<tr>
<td>Pakistan</td>
<td>980</td>
<td>10.6</td>
<td>20</td>
<td>35</td>
<td>16</td>
</tr>
<tr>
<td>Saudi Arabia</td>
<td>15,500</td>
<td>5.3</td>
<td>2.5</td>
<td>20</td>
<td>0</td>
</tr>
<tr>
<td>Senegal</td>
<td>970</td>
<td>19.2</td>
<td>50</td>
<td>25</td>
<td>18</td>
</tr>
<tr>
<td>Singapore</td>
<td>34,760</td>
<td>13</td>
<td>20</td>
<td>17</td>
<td>7</td>
</tr>
<tr>
<td>South Africa</td>
<td>5,820</td>
<td>26.9</td>
<td>40</td>
<td>28</td>
<td>14</td>
</tr>
<tr>
<td>Thailand</td>
<td>2,840</td>
<td>17</td>
<td>37</td>
<td>30</td>
<td>7</td>
</tr>
<tr>
<td>United Arab Emirates</td>
<td>NA</td>
<td>1.4</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>USA</td>
<td>47,580</td>
<td>28.2</td>
<td>35</td>
<td>35</td>
<td>0</td>
</tr>
<tr>
<td>Vietnam</td>
<td>890</td>
<td>13.8</td>
<td>35</td>
<td>25</td>
<td>10</td>
</tr>
<tr>
<td>Zambia</td>
<td>950</td>
<td>16.1</td>
<td>35</td>
<td>35</td>
<td>16</td>
</tr>
</tbody>
</table>


Appendix 6: Nepal: Methods for Revenue Mobilization during the Short Run (Major Taxes only)

<table>
<thead>
<tr>
<th>Tax Headings</th>
<th>Strategy</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>Indirect Taxes</td>
<td>Implementation of multi-rates after study by the govt.; Problems such as under-invoicing and non-issue of bills should be resolved; number of taxpayers under VAT to be increased in cooperation with private sector - FNCCI, CNI, Chamber of Commerce etc.</td>
<td>The contribution is around 60.0 percent of total revenue. The share VAT is approximately 30.0 percent of total revenue</td>
</tr>
<tr>
<td>VAT</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Customs Duties (Import Duties)</td>
<td>Import duties might go down gradually due to WTO, SAFTA and BIMSTEC provisions; Binding constraints are too lowering down import duties between 0-5.0 and maximum 20.0 percent during the stipulated timeframe.</td>
<td>Need to go for Free Trade Area (FTA) with India and China earliest possible; Sri Lanka has already entered into FTA with India, and Bangladesh is preparing to negotiate with India for FTA; As long as an economy is poor and backward heavy</td>
</tr>
</tbody>
</table>
reliance would be on import duties.

<table>
<thead>
<tr>
<th>Excise Duties</th>
<th>Excise duties on cigarette, bidi, liquor and beer could be moderately increased with a minimum contribution to create a fund for health.</th>
<th>The contribution is around 10.0 percent of GDP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Direct Taxes</td>
<td>This is premier direct tax; Rates for personal and business income tax, and corporate tax should be lowered down by 5.0 percent (from 25% to 20%) to provide incentive to investors ensuring growth; Survey should be conducted to identify new taxpayers; Strengthen self-assessment system.</td>
<td>Contribution is around 20.0 percent inclusive of house and land registration</td>
</tr>
<tr>
<td>Income Tax</td>
<td>Contribution is nearly 18.0 percent of total revenue</td>
<td></td>
</tr>
<tr>
<td>House and Land Registration Tax</td>
<td>The local bodies should be authorized to collect this tax and also spending assignment should be given to them</td>
<td>Share around 2.0 percent</td>
</tr>
<tr>
<td>Non-Tax Revenue</td>
<td>Emphasis should be on collecting more revenue through user charges.</td>
<td>Example: Telephone and Electricity</td>
</tr>
<tr>
<td>Local taxes</td>
<td>Integrated property tax should be implemented in Municipalities; Revenue mobilization depends on the proposed federal structure.</td>
<td>This would combine land tax, house and land tax etc.</td>
</tr>
<tr>
<td>New tax imposts</td>
<td>Implementation of Voluntary disclosure of Income Scheme (VDIS).</td>
<td>This should not be a regular business</td>
</tr>
<tr>
<td>Tax administration</td>
<td>Leakages should be checked through restraining corruption; Tax administration should be made effective, honest and dynamic by inducting reward and punishment system for tax officials; Corrupt officials should be dismissed.</td>
<td>MOF should introduce code of conduct for tax officials</td>
</tr>
<tr>
<td>Taxpayers</td>
<td>Need for providing dignified treatment to the taxpayers.</td>
<td>State should honor highest taxpayers as CIP</td>
</tr>
<tr>
<td>The role of Government</td>
<td>Strong political will and determination of the govt. is required to implement the proposed tax policy; Strong action should be taken for tax delinquency; Defaulters should be given ultimatum of three months to clear the loans taken from the banks; Govt. should earmark expenditure for providing pure public or merit goods.</td>
<td>Efficiency most essential</td>
</tr>
<tr>
<td>The role of private sector</td>
<td>Attract FDI in joint ventures in cooperation with govt., which will provide capital, technology and employment. Employment is a key to development.</td>
<td>Efficiency most essential</td>
</tr>
</tbody>
</table>

* This is a preliminary proposal developed by the author.

Appendix 7: The 10 nations with best Tax-to-GDP figures are: Denmark (50 per cent), Sweden (49.7 per cent), Zimbabwe (49.3 per cent), Belgium (46.8 per cent), France (46.1 per cent), Cuba (44.8 per cent), Finland (43.6 per cent), Norway (43.6 per cent), Lesotho (42.9 per cent) and Italy (42.6 per cent).

Appendix 8: Case Study: Fertilizer Subsidies in India

The Wall Street journal report of 22 February 2010 “Green Revolution in India Wilt as Subsidies Backfire”: “India has been providing farmers with heavily subsidized fertilizer for more than three decades. The overuse of one type - urea - is so degrading the soil that yields on some crops are falling and import levels are rising. So are food prices, which jumped 19% last year. The country now produces less rice per hectare than its far poorer neighbors: Pakistan, Sri Lanka and Bangladesh. [The] cabinet announced that India would adopt a new subsidy program in April, hoping to replenish the soil by giving farmers incentives to use a better mix of nutrients. But in a major compromise, the government left in place the old subsidy on urea - meaning farmers will still have a big incentive to use too much of it.”
“Under the new plan, the government will offer subsidies to fertilizer companies on the nutrients, such as sulphur, phosphorus and potassium, from which their products are made, rather than the fertilizer products themselves. The idea is to provide incentives for farmers to apply a better mix of nutrients. Ultimately, the government plans to pay the subsidy directly to farmers, who will be able to buy products of their choice, including but not limited to urea. [The] government, however, said it would continue to subsidize urea, although it would set the price 10% higher.”

Source: http://online.wsj.com/article/SB10001424052748703615904575052921612723844.html

Appendix 8: Land Revenue as % of Total Revenue, 1974/75 - 2009/10 (Rs. in millions)

<table>
<thead>
<tr>
<th>FY</th>
<th>Total Revenue</th>
<th>Land Revenue</th>
<th>In % of Total Revenue</th>
</tr>
</thead>
<tbody>
<tr>
<td>1974/75</td>
<td>84.17</td>
<td>9.09</td>
<td>11.8</td>
</tr>
<tr>
<td>1975/76</td>
<td>90.86</td>
<td>9.48</td>
<td>10.4</td>
</tr>
<tr>
<td>1976/77</td>
<td>110.01</td>
<td>9.79</td>
<td>8.8</td>
</tr>
<tr>
<td>1977/78</td>
<td>124.39</td>
<td>8.70</td>
<td>7.0</td>
</tr>
<tr>
<td>1978/79</td>
<td>147.68</td>
<td>5.46</td>
<td>3.7</td>
</tr>
<tr>
<td>1979/80</td>
<td>153.88</td>
<td>5.62</td>
<td>3.8</td>
</tr>
<tr>
<td>1980/81</td>
<td>203.57</td>
<td>10.07</td>
<td>4.9</td>
</tr>
<tr>
<td>1981/82</td>
<td>221.13</td>
<td>8.17</td>
<td>3.7</td>
</tr>
<tr>
<td>1982/83</td>
<td>242.61</td>
<td>6.67</td>
<td>2.7</td>
</tr>
<tr>
<td>1983/84</td>
<td>273.70</td>
<td>7.72</td>
<td>2.8</td>
</tr>
<tr>
<td>1984/85</td>
<td>315.12</td>
<td>7.69</td>
<td>2.4</td>
</tr>
<tr>
<td>1985/86</td>
<td>365.93</td>
<td>7.42</td>
<td>2.0</td>
</tr>
<tr>
<td>1986/87</td>
<td>437.17</td>
<td>7.24</td>
<td>1.7</td>
</tr>
<tr>
<td>1987/88</td>
<td>575.28</td>
<td>8.07</td>
<td>1.4</td>
</tr>
<tr>
<td>1988/89</td>
<td>628.72</td>
<td>8.04</td>
<td>1.3</td>
</tr>
<tr>
<td>1989/90</td>
<td>728.39</td>
<td>7.46</td>
<td>1.0</td>
</tr>
<tr>
<td>1990/91</td>
<td>817.63</td>
<td>8.21</td>
<td>1.0</td>
</tr>
<tr>
<td>1991/92</td>
<td>987.36</td>
<td>6.48</td>
<td>0.7</td>
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<tr>
<td>1992/93</td>
<td>1,166.25</td>
<td>6.94</td>
<td>0.6</td>
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<tr>
<td>1993/94</td>
<td>1,537.15</td>
<td>6.10</td>
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<tr>
<td>1994/95</td>
<td>1,966.00</td>
<td>3.49</td>
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<tr>
<td>1995/96</td>
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<td>1.82</td>
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</tr>
<tr>
<td>1996/97</td>
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<td>0.02</td>
</tr>
<tr>
<td>1997/98</td>
<td>2,593.98</td>
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<td>0.01</td>
</tr>
<tr>
<td>1998/99</td>
<td>2,875.29</td>
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<td>0.00</td>
</tr>
<tr>
<td>1999/00</td>
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<td>0.00</td>
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<td>3,886.50</td>
<td>0.51</td>
<td>0.01</td>
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<tr>
<td>2001/02</td>
<td>3,933.06</td>
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<td>0.00</td>
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<tr>
<td>2003/04</td>
<td>4,817.30</td>
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<td>-</td>
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<tr>
<td>2004/05</td>
<td>5,410.47</td>
<td>0.00</td>
<td>-</td>
</tr>
<tr>
<td>2005/06</td>
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<td>-</td>
</tr>
<tr>
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<td>7,112.67</td>
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<td>-</td>
</tr>
<tr>
<td>2007/08</td>
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<td>-</td>
</tr>
<tr>
<td>2008/09</td>
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<td>-</td>
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<tr>
<td>2009/10</td>
<td>15,629.49</td>
<td>0.00</td>
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</table>


References


http://online.wsj.com/article/SB10001424052748703615904575052921612723844.html


http://www.taxrates.cc

Impact of Climate Change on Agricultural Production in Nepal

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Abstract

This paper has adopted the Ricardian approach to measure the effect of climate change on crop production in Nepal using both cross-section and time-series climatic data. Net farm revenue is regressed on climate and socio-economic variables. The findings show that these variables have a significant impact on the net farm revenue per hectare. More specifically, relatively low precipitation and high temperature seem to have a positive impact on net farm revenue during the fall and spring seasons. Net farm revenue is likely to be increased by summer precipitation, but not by temperature. Marginal impacts are mostly in line with the Ricardian model, showing marginally increasing precipitation during summer and winter would increase net farm revenue, but reduce by the quarter terms and temperature of these seasons. Marginally increasing precipitation would increase farm income in the hilly region, but reduce it in the Tarai region. Moreover, paddy and wheat yields are highly sensitive to the variability of precipitation. Conclusively, the impact of climate change on crop production seems to be varied in different climatic zones as well as crops.

Keywords: climate change, agriculture, Ricardian approach, marginal impact, yield, Nepal

JEL: C31 Q24 Q54

1. Introduction

There is a growing concern about the effect of climate change on human life, as the scientific consensus grows that significant climate change is very likely to occur over the 21\(^{st}\) century (Christensen and Hewitson, 2007). Climate change can have both direct and indirect impact on the general well-being of the people in which the community who primarily depend on natural resources such as agriculture and forest for their livelihood are likely to be most affected by climate change. With regard to agriculture, the general consensus is that changes in temperature and precipitation will result in changes in land and water regimes that will subsequently affect agricultural productivity (World Bank, 2003). There is an increasing concern about the impact of climate change on agriculture in developing countries with changing global climate (IPCC, 1996) and some attempts have been made to estimate this impact (Winter et al., 1996; Dinar et al., 1998; Kumar and Parikh, 1998; Mendelsohn and Tiwari, 2000). The impact of climate
change on agriculture is therefore a matter of concern, particularly in the low income countries where a majority of people live in rural areas and depend on agriculture for their livelihood. An understanding of the impact of climate change on agriculture in the developing world is likely to be critical for its distributional effects as well as for formulating policies to reduce its magnitude.

This paper aims to assess the impact of climate change on agriculture in Nepal. The study on the impact of climate change on agriculture seems to be plausible in Nepal due to higher dependency of the people on agricultural sector for livelihoods. Previous studies on the impact of climate change on agriculture show a prediction of reduction in agriculture yields, particularly in tropical regions (Mendelsohn and Dinar, 1999; Kurukulasuriya and Rosenthal, 2003). Literature also shows that climate change would have serious impacts on agriculture in developing countries (Pearce et al., 1996; Tol, 2002; Mendelsohn et al., 2006). These studies further reveal that large adverse impacts on agricultural productivity, especially among the smallholders can lead to a rise in poverty levels (World Bank, 2003). This paper thus intends to add the literature on the economics of climate change and contributes to the research on measuring the potential impacts of climate change in low income countries like Nepal.

Studies on the impact of climate change on agriculture have been increasing since the last decade in which two main approaches are widely used to assess the impact of climate change (Mendelsohn, 2007); one is simulation models that obtain parameters from controlled experiments and another one is cross-sectional analysis observing the (economic) system across different locations in order to determine how the system may adapt to different climatic conditions. The second method is widely known as the Ricardian approach which corresponds to the Hedonic Pricing of environmental attributes (Libert et al., 2009). This paper applies the second method to measure the effect of climate change using cross-section data of more than 656 households covering 14 districts of Nepal.

The paper is organized as follows. After providing a background to climate change in the introduction part, an overview of Nepalese agriculture is given in Section 2. Section 3 discusses the method applied to measure the impact of climate change on agriculture. Section 4 presents data sources and descriptive statistics, while the findings of econometric model are given in Section 5. The paper ends with conclusion in Section 6.

2. Overview of Nepalese Agriculture

Nepal is traditionally an agrarian country in which subsistence and semi-commercial agriculture dominate this sector. About two-thirds of the economically active population is engaged in agriculture and agriculture sector contributes about one-third to GDP. The variability of agricultural productivity due to climate change may have a significant impact on people depending on this sector, especially the poor and smallholders.

In Nepal, the total cultivated land area available is 2.97 million hectares, out of which, about 0.99 million hectare is cultivated. The average landholding is only 0.8 hectares and about 75 percent landholdings are of small size having less than 1 hectare (CBS, 2002). Despite a small
country with a large number of smallholders, Nepal is divided into three main climatic zones: alpine (area above 10,000 feet from sea level); temperate (area between 2,000 to 1,000 feet temperature varying between 32˚ F and 100˚ F); and sub-tropical (area between 200 to 2,000 feet with temperature 50˚ F to more than 100˚ F). Cropping patterns and crops also vary in different climatic zones (often called as agro-ecological belts). Rice and wheat are the major cereal crops in Tarai, i.e. southern plain area, while maize and finger millet are the main crops in the hills and the mountain region, especially grown on marginal lands with low productivity. In addition to traditional and staple crops, there is also a trend of cultivating other non-staple crops such as legumes, seasonal vegetables, potatoes, and other cash crops. However, agricultural commercialization has yet to occur in a tangible way. Policymakers and economists often believe that the major constraints in agricultural commercialization including low productivity are poor infrastructure and high dependency on weather. Due to lack of sufficient irrigation facility, Nepalese agriculture depends on monsoon rain. As the country belongs to the monsoon zone, the major staple crops are cultivated in this season; therefore the degree of rainfall has a significant impact on productivity and food security in Nepal. In a country where rainfed production system dominates, it is plausible to assess the impact of climate (e.g. precipitation and temperature) change on agriculture.

A study based on an analysis of temperature trends in Nepal from 1977 to 1994 (collected from 49 stations), indicates a consistent and continuous warming during the period at an annual rate of 0.06°C (MoENV, 2010). A similar study conducted by Practical action (2009), looking at data from 45 weather stations for the period 1976-2005, indicates a consistent and continuous warming of maximum temperatures at an annual rate of 0.04°C. These studies also indicate that the observed warming trend in the country is spatially variable.

3. Measuring Impact of Climate Change on Agriculture

This study has adopted the Ricardian method developed by Mendelsohn et al. (1994) to measure the value of climate in US agriculture. The analysis is based on the assumption of a direct cause and effect relationship between climate events and farm value. This technique is applied under the assumption of perfect competition in which Ricardo observed that land values would reflect land productivity at a site. In other words, the Ricardian method has been applied to assess the contribution of environmental conditions to farm income.

The Ricardian approach is preferred to the traditional estimation methods, given that instead of ad hoc adjustments of parameters characteristic of traditional approach, this technique automatically incorporates efficient adaptation by farmers to climate change (World Bank, 2003) and the use of net revenue reflects benefits and costs of implicit adaptation strategies. More specifically, Ricardian analysis incorporates substitution of various inputs and introduction of alternative activities each farmer has adopted in light of the existing climate (Kurkurlasuriya et al., 2006). The advantage in applying this model is that it is cost-effective, since secondary data on cross-sectional sites can be relatively easy to collect on climate, production, and socio-economic factors (Deressa and Hassan, 2009).
Despite its strengths, the approach as a cross-section analysis does not account for dynamic transition costs which can occur as farms move between two states. Likewise, Ricardian approach fails to fully control the impact of important variables that could explain variation in farm income. Another criticism of this method is the assumption of constant prices (Cline, 1996): the inclusion of price effects is problematic and the approach is weak here (Mendelsohn et al., 1994). These problems are significant but not fatal (Mendelsohn, 2001).

The analysis of climate change impact on agriculture applying the Ricardian approach uses net farm revenue as a dependent variable, a more robust measure, given the concern about equilibrium as it measures what the farmer currently receives without any concern for future returns, discounting capital or labor markets (World Bank, 2003). It is often mentioned in the literature that the Ricardian theory is consistent when net revenue instead of land value is used, because land values are based on the discounted stream of future net revenues (Kurkurulasuriya and Ajwad, 2006). As the data on the worth of net revenue are based on the cross-section survey of the year 2003/04, we ensure that the survey year is not influenced by any unusual, year-specific climatic activity that can otherwise be problematic if both prices and productivity are affected. Moreover, the Ricardian model seems to be plausible in developing countries due to insufficient research and experiments to apply other models such as agro-economic model (Seo et al., 2005).

The Ricardian approach followed by Mendelsohn et al. (1994, 1999) is the net revenue function of the form:

\[ \Pi = \sum P_i Q_i (X, C, Z) - \sum P_x X, \]

where \( \Pi \) is the net revenue per hectare, \( P_i \) is the market price of crops \( i \), \( Q_i \) refers to the output of crop \( i \), \( X \) is the vector of purchased inputs, \( C \) is a vector of climate variables, \( Z \) is a set of household and land characteristics, and \( P_x \) is a vector of input prices.

The Ricardian model is based on the assumption that farmer will maximize net farm revenues by choosing inputs (\( X \)) subject to climate and other socio-economic variables. In other words, this model is applied only when we expect farmers to be price takers in all markets. If this assumption is violated, the estimates of the function are meaningless from an economic point of view. Therefore, the standard Ricardian model is presented in a non-linear functional form where net farm value per hectare is regressed on climate and other socio-economic variables:

\[ \Pi = \alpha_0 + \alpha_1 C + \alpha_2 C^2 + \alpha_3 Z + \mu, \] where \( \mu \) is the error term.

Marginal values are often calculated to measure the marginal impacts of a change in climate variables and these values depend on the regression equation being used and the climate which is being evaluated. The expected marginal impact of a single climate variable, \( C_i \) on net farm income evaluated at the mean is:

\[ E[\partial \Pi/\partial C_i] = \alpha_{1,i} + 2 \times \alpha_{2,i} \times E[C_i] \]
In this equation, the linear formulation of the model indicates uni-directional impact of independent variables on the dependent variable, while the nonlinear term shows the non-linear shape of the net revenue of the climate response function. It is noteworthy that the net revenue function is U-shaped in case of the quadratic term being positive and hill-shaped in case the quadratic term is negative.

In addition to the application of Ricardian model that allows both cross-section household and time series climate data, the study also performed a statistical analysis to determine the relationship between first difference of yield and climate variables (precipitation and temperature) from a period of 1975 to 2005 as applied by Nicholls (1997) and Lobell et al. (2005). The regression model is presented in the form:

\[
\Delta \text{Yield} = \theta_0 + \theta_1 \Delta \text{Preci} + \theta_2 \Delta \text{Temp} + \omega, \quad \text{where } \Delta \text{Yield}, \text{ is the first difference of yield of crops, such as paddy rice, wheat, maize, millet, barley, and potato; } \Delta \text{Preci} \text{ and } \Delta \text{Temp} \text{ are the first difference of average precipitation and temperature from the year of 1975 to 2005; } \theta_i \text{s are the parameters to be estimated and } \omega \text{ is an error term.}
\]

\section*{4. Data Sources and Analysis}

The study uses data obtained from Nepal Living Standard Survey 2003/04 (NLSS II) of the Central Bureau of Statistics, Nepal. The methodology used in the NLSS II was applied in more than 50 developing countries by the World Bank with the purpose of the Government to monitor progress in improving living conditions and to evaluate the impact of government policies and programs in the country. NLSS II is the second national survey of Nepal conducted by the Central Bureau of Statistics, Nepal with technical and financial support from the World Bank. The survey applied two-stage sampling procedure to select the sample for the first stage of the survey (e.g. NLSS 1995/96), in which the smallest administrative unit (i.e. the ward of Village Development Committees) was considered as the primary sampling unit (PSU) for the survey.

The NLSS II selected 275 wards with probability proportional to size (PPS) from each of the four ecological strata, where size was measured from the number of households in the ward. For NLSS II, the number of households in each PSU was fixed at twelve. The total sample size was 4008 households. However, only 3912 households consisting of 408 households from the mountain, 1968 households from the hills, and 1632 households from the Tarai (the southern plain) were enumerated because of insurgency during field survey. Out of 3912 households, this study uses only 656 households of 14 districts.

NLSSs provide a large number of data set about agricultural activities including information on demographic characteristics, household activities, both farm and off-farm, education and literacy, employment status in both farm and off-farm, wage rates and remittances covering all administrative and ecological zones. For the purpose of this study, information includes farm size, farm income, cost of inputs, household size, farm credit, distance to input market, and locational characteristics.
Table 1: Descriptive statistics

<table>
<thead>
<tr>
<th>Variable</th>
<th>Variable description</th>
<th>Mean</th>
<th>Std. Deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Net farm income</td>
<td>Income from farm products plus sale of animal income and other products (in Nepalese Rupees)</td>
<td>2,572.86</td>
<td>251.82.64</td>
</tr>
<tr>
<td>Farm size</td>
<td>Farm land both owned and sharecropped (in hac)</td>
<td>0.74</td>
<td>1.06</td>
</tr>
<tr>
<td>Irrigation ratio</td>
<td>Ratio of irrigated land to total farm land</td>
<td>0.51</td>
<td>0.44</td>
</tr>
<tr>
<td>Age</td>
<td>Household's Head age</td>
<td>46.47</td>
<td>14.38</td>
</tr>
<tr>
<td>Sex</td>
<td>Household Head sex</td>
<td>0.81</td>
<td>0.38</td>
</tr>
<tr>
<td>Edulevel</td>
<td>Years of schooling of household head</td>
<td>3.60</td>
<td>4.37</td>
</tr>
<tr>
<td>HHsize</td>
<td>Total number of household members</td>
<td>5.3</td>
<td>2.5</td>
</tr>
<tr>
<td>Mktcenter</td>
<td>Distance to input markets (walking hours)</td>
<td>0.41</td>
<td>0.25</td>
</tr>
<tr>
<td>Farm loan</td>
<td>Whether or not farmer received loan</td>
<td>0.62</td>
<td>0.48</td>
</tr>
<tr>
<td>w_preci</td>
<td>Winter precipitation (December-February) (mm)</td>
<td>23.24</td>
<td>9.22</td>
</tr>
<tr>
<td>w_temp</td>
<td>Winter temperature (December-February) (°C)</td>
<td>11.94</td>
<td>3.84</td>
</tr>
<tr>
<td>sp_preci</td>
<td>Spring precipitation (March-May) (mm)</td>
<td>57.26</td>
<td>33.63</td>
</tr>
<tr>
<td>sp_temp</td>
<td>Spring temperature (March-May) (°C)</td>
<td>22.36</td>
<td>5.44</td>
</tr>
<tr>
<td>su_preci</td>
<td>Summer precipitation (June-August) (mm)</td>
<td>589.59</td>
<td>298.75</td>
</tr>
<tr>
<td>su_temp</td>
<td>Summer temperature (June-August) (°C)</td>
<td>25.46</td>
<td>4.27</td>
</tr>
<tr>
<td>fal_preci</td>
<td>Fall precipitation (September-November) (mm)</td>
<td>78.29</td>
<td>45.55</td>
</tr>
<tr>
<td>fal_temp</td>
<td>Fall temperature (September-November) (°C)</td>
<td>21.51</td>
<td>4.95</td>
</tr>
</tbody>
</table>

Total number of observations 656

In addition to household data, climate data such as temperature and precipitation were obtained from the Department of Hydrology and Meteorology, Ministry of Environment, Nepal where the data covers a period of more than 30 years - from 1964 to 2006. Crop yield data were collected from the yearly publication of the Ministry of Agricultural Development.

Descriptive statistics of the data used in this paper are given in Table 1. Net crop output\(^{23}\) is the income received from farm products and by products of farm minus the total input cost including labor, fertilizer, seed and other costs in Nepalese rupees. In other words, the total input cost is the cost paid by farm household either in cash or kind. Total farm land is the land used by the household for agricultural activities either owned, or rented, or sharecropped during the survey year and measured in hectare. Irrigation ratio is considered as the measurement of land quality which is common in these exercises.

The results of mean and standard deviation show that despite the small size of the country, there are wide variations in precipitation and temperature. Variations in means and standard deviations are also found in net farm income per hectare, age, and family size.

Figure 1: Yield and climate variables relationship, 1975 – 2005

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\(^{23}\) This paper frequently uses both net farm income and crop output, representing same meaning. Do not consider different meanings and values.
Figure 1 displays the relationship between total cereal crop yield and climate variables (precipitation and temperature), indicating that yield has been generally higher in the higher precipitation period, but not high during high temperature periods. The correlation coefficient (0.48, P<0.006) also reveals higher correlation between yield and precipitation, suggesting that cereal crop yield is highly sensitive to the variability of precipitation.

5. Econometric results

The results of Ricardian models presented in Table 2 show both marginal impacts of the quarterly precipitation rates and temperature (in Model 1). However, some of quarterly temperature is omitted from the model due to the problem of collinearity. In Model 2, other socio-economic and land characteristics are included to find out the impact of such characteristics on the net farm revenue per hectare. As discussed earlier, the dependent variable of the model is net farm income per hectare (in Nepalese currency, i.e. NRs.), while exogenous variables are precipitation rate, temperature, and other socio-economic characteristics. The second model includes farm size and ratio of irrigated land, assuming that irrigated land reflects the quality of the land, thus, ratio of irrigated land is a proxy for land quality. Variables, such as distance to input markets and obtaining farm credit are often determining factors for agricultural productivity, particularly in the developing world. Hence, these variables are included in the analysis. In addition, socio-economic characteristics, such as household size, age, sex, and education level of the household head are also included in the model, implying that such variables do matter in the agricultural productivity. For instance, age of the household is often used as a proxy variable for farm experience.

Prior to the econometric specifications, several diagnostic tests were carried out. First, normality test in residual by the Shapiro-Wilks asymptotic test was performed which was rejected, revealing that the estimated coefficients are consistent. Second, since the data set is cross-sectional and covers wide variation in the region, the probability of heteroscedasticity is high.
So, heteroscedasticity test (Breusch-Pagan / Coed Weisberg) was performed and there was presence of heteroscedasticity. Then robust standard errors are reported in the estimated coefficients.

Model 1 which displays marginal impacts of climate variables on net farm income per hectare is presented in Table 2. The marginal effects of precipitation and temperature are calculated at mean for each sample. The $R^2$ value (0.10) shows that climatic variables explain only about 10 percent of this variation in farm value, while F-statistic implies the function to be well behaved.

The findings of Model 1 show that the most estimated coefficients are significant at required levels. The results of marginal impact show that precipitation in the summer and winter has a positive impact on farm value (i.e. increasing returns), while spring and fall precipitation have a negative one (indicating diminishing returns). The square terms reveal that doubling the spring and fall precipitation can lead to a positive impact on farm value, but winter and summer precipitations lead to reduction in the net farm income.

Model 2 estimates the econometric equation incorporating both climate and other socio-economic variables. The $R^2$ value explains about 11 percent of the variation in net farm revenue per hectare. The test result of F-statistic shows that the function is well-behaved. The findings show that the most estimated coefficients of climate combined with some socio-economic variables are significant, implying the impact of these variables on farm value. For instance, there is a positive impact of spring and summer precipitation but a negative impact of fall precipitation on farm income. Strong positive impact of spring and fall temperature found on net farm revenue, while, as expected, summer temperature has a negative impact on farm value. However, the negative impact of winter temperature on farm value is a bit surprising, at least in this data set. Intuitively, the negative impact of winter temperature may be due to low productive crops such as wheat planted in the winter season.

The productivity of winter crop may be low in the mountain and hilly regions due to the extreme cold temperature. This result needs to be interpreted with caution. The findings of other variables show mixed results. For instance, higher farm output is observed in irrigated farmlands compared to non-irrigated farmlands, but productivity is high in small farms than large farms, showing inverse farm size and productivity relationship. Farmers who obtained credit increased their farm income, showing common problems in low-income countries where credit is one of the constraints for small farmholders. The coefficient of household head’s education is significant and negative, implying a negative relationship to net farm income. This result seems to be a bit surprising. Probably educated people preferred to work in the off-farm sector due to low wages and returns in the agricultural sector. Moreover, other variables such as sex and age of household head, distance from input markets, and family size are not significant at any required level, indicating no impact of these variables on farm value at least in this model and data set.

Table 2: Regression equations of the determinants of net farm revenue
<table>
<thead>
<tr>
<th>Variable</th>
<th>Model 1</th>
<th>Model 2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Winter precipitation</td>
<td>649.77***</td>
<td>-19.53</td>
</tr>
<tr>
<td></td>
<td>(3.63)</td>
<td>(1.56)</td>
</tr>
<tr>
<td>Winter precipitation square</td>
<td>-9.63***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.44)</td>
<td></td>
</tr>
<tr>
<td>Spring precipitation</td>
<td>-259.15**</td>
<td>12.96***</td>
</tr>
<tr>
<td></td>
<td>(2.78)</td>
<td>(4.02)</td>
</tr>
<tr>
<td>Spring precipitation square</td>
<td>1.01**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.73)</td>
<td></td>
</tr>
<tr>
<td>Summer precipitation</td>
<td>101.21***</td>
<td>4.67***</td>
</tr>
<tr>
<td></td>
<td>(4.02)</td>
<td>(4.58)</td>
</tr>
<tr>
<td>Summer precipitation square</td>
<td>-0.10***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.76)</td>
<td></td>
</tr>
<tr>
<td>Fall precipitation</td>
<td>-261.09***</td>
<td>-31.02***</td>
</tr>
<tr>
<td></td>
<td>(3.47)</td>
<td>(4.46)</td>
</tr>
<tr>
<td>Fall precipitation square</td>
<td>3.50***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(3.56)</td>
<td></td>
</tr>
<tr>
<td>Winter temperature</td>
<td>-1192.1*</td>
<td>-713.4***</td>
</tr>
<tr>
<td></td>
<td>(1.95)</td>
<td>(3.42)</td>
</tr>
<tr>
<td>Winter temperature square</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spring temperature</td>
<td>523.25</td>
<td>891.15***</td>
</tr>
<tr>
<td></td>
<td>(1.48)</td>
<td>(3.83)</td>
</tr>
<tr>
<td>Spring temperature square</td>
<td>-17.07</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(1.40)</td>
<td></td>
</tr>
<tr>
<td>Summer temperature</td>
<td>-943.16***</td>
<td>-468.43**</td>
</tr>
<tr>
<td></td>
<td>(4.01)</td>
<td>(3.19)</td>
</tr>
<tr>
<td>Summer temperature square</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fall temperature</td>
<td>1014.55*</td>
<td>26.53</td>
</tr>
<tr>
<td></td>
<td>(1.78)</td>
<td>(0.7)</td>
</tr>
<tr>
<td>Fall temperature square</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm size</td>
<td>-184.51**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.22)</td>
<td></td>
</tr>
<tr>
<td>Ratio of irrigated land in the total land</td>
<td>545.39**</td>
<td>(2.65)</td>
</tr>
<tr>
<td>Distance from input market</td>
<td>-55.34</td>
<td>(0.15)</td>
</tr>
<tr>
<td>Farm credit</td>
<td>516.19**</td>
<td>(2.20)</td>
</tr>
<tr>
<td>Age of household head</td>
<td>4.78</td>
<td>(0.66)</td>
</tr>
<tr>
<td>Sex of household head</td>
<td>17.15</td>
<td>(0.7)</td>
</tr>
<tr>
<td>Education level of household head</td>
<td>-45.92*</td>
<td>(1.67)</td>
</tr>
<tr>
<td>Household family size</td>
<td>51.56</td>
<td>(0.79)</td>
</tr>
<tr>
<td>Constant</td>
<td>-7702.68</td>
<td>-828.87</td>
</tr>
<tr>
<td></td>
<td>(1.19)</td>
<td>(0.78)</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.10</td>
<td>0.11</td>
</tr>
<tr>
<td>F-statistics</td>
<td>F(13, 634)=7.32***</td>
<td>F(16, 639)=6.39***</td>
</tr>
</tbody>
</table>

**Total observations** 656

***, **, * 1, 5 and 10 percent level of significance respectively; t-statistics are given in the parentheses; some square terms of climate variables omitted in Model 2 due to the problem of multi-collinearity.

Despite some surprising results about precipitation and temperature, the other findings are in line with the conventional hypothesis of climate change impact on agriculture, implying that rising temperature is likely to reduce farm output. The negative impact of fall and spring precipitation on farm value seems to be reasonable in Nepalese context, because these two seasons are the period of harvesting major crops, such as paddy rice and maize (in fall) and wheat (in spring). If
relatively high precipitation occurs during these seasons, there is high probability of damage to the crop output during the harvesting time. On the other hand, high temperature with low precipitation during spring and fall is more likely to be supportive for timely harvesting of cereal crops and reducing the loss of crop output. The positive impact of summer precipitation is also plausible because of heavy dominance of rainfed agriculture in Nepal, indicating that timely precipitation in the summer helps to plant paddy rice and other seasonal crops on time thereby increasing productivity.

Table 3: Marginal impacts of climate change on agriculture in different climatic zones

<table>
<thead>
<tr>
<th></th>
<th>Mountain (Alpine zone)</th>
<th>Hills (Temperate zone)</th>
<th>Tarai (Semi-tropical zone)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>19.34</td>
<td>15.55</td>
<td>-211.56</td>
</tr>
<tr>
<td>Precipitation</td>
<td>-3.69</td>
<td>1.36*</td>
<td>-24.93**</td>
</tr>
</tbody>
</table>

** and * 5 & 10 percent significant level.

Marginal effects of climate change on agriculture are also evaluated among the ecological belts such as mountain, hills and Tarai (Table 3). Annual average precipitation is likely to increase farm value in the hilly region, but reduce it in the Tarai. Temperature has a positive impact on farm value in alpine and temperate zones and a negative one in the sub-tropical zone, but these coefficients are not statistically significant at the required level. However, these findings indicate some trends as to how the impact of temperature and precipitation on net farm income per hectare varies in different climatic zone.

Table 4: Multivariate linear regression results between first difference of yield and climate conditions (1975 to 2005)

<table>
<thead>
<tr>
<th></th>
<th>All cereal crops</th>
<th>Paddy rice</th>
<th>Wheat</th>
<th>Maize</th>
<th>Millet</th>
<th>Barley</th>
<th>Potato</th>
</tr>
</thead>
<tbody>
<tr>
<td>Precipitation</td>
<td>13.02***</td>
<td>9.17***</td>
<td>2.47**</td>
<td>1.30</td>
<td>-0.04</td>
<td>0.13</td>
<td>6.73</td>
</tr>
<tr>
<td></td>
<td>(4.58)</td>
<td>(3.00)</td>
<td>(1.18)</td>
<td>(1.69)</td>
<td>(0.72)</td>
<td>(0.67)</td>
<td>(8.37)</td>
</tr>
<tr>
<td>Temperature</td>
<td>-128.67</td>
<td>-69.43</td>
<td>21.05</td>
<td>-74.61</td>
<td>-13.72</td>
<td>8.07</td>
<td>32.08</td>
</tr>
<tr>
<td></td>
<td>(156.83)</td>
<td>(102.78)</td>
<td>(40.44)</td>
<td>(57.86)</td>
<td>(24.69)</td>
<td>(22.88)</td>
<td>(286.49)</td>
</tr>
<tr>
<td>Constant</td>
<td>26.03</td>
<td>21.25</td>
<td>30.41**</td>
<td>5.43</td>
<td>-1.23</td>
<td>4.34</td>
<td>237.89</td>
</tr>
<tr>
<td></td>
<td>(54.9)</td>
<td>(35.99)</td>
<td>(14.16)</td>
<td>(20.29)</td>
<td>(8.64)</td>
<td>(8.01)</td>
<td>(100.32)</td>
</tr>
<tr>
<td>R²</td>
<td>0.25</td>
<td>0.27</td>
<td>0.14</td>
<td>0.08</td>
<td>0.02</td>
<td>0.01</td>
<td>0.02</td>
</tr>
</tbody>
</table>

Note: Std. Errors are in parentheses. *** and ** significance at 1 and 5 percent level.

Furthermore, Table 4 presents the result of multivariate linear regression between the first difference of yield and climate conditions (1975 to 2005). R-square shows that more than 25 percent of the variability in crop yields mainly in all cereal crops and paddy rice can be explained by variability in precipitation and temperature between 1975 and 2005. The significant positive sign of precipitation in all cereal crops, paddy rice, and wheat shows that relatively higher precipitation has led to higher yields of these crops, implying that these crops, mainly paddy rice, and wheat are sensitive to climate change. This result seems to be plausible due to the fact that paddy rice has higher requirements of water and is highly sensitive to droughts.
contrast to this, as the temperature coefficients are not significant at any level, the negative signs indicate that increase in temperature may be associated with lower yields. In other words, temperature does not seem to be sensitive with crop yields in these data.

6. Conclusions

Climate change is widely acknowledged as a global concern due to its large effects on human life. Climate change can have multiple impacts on the livelihoods of the people. For instance, impacts of climate variability and change on agricultural sector are projected through changes in land and water regimes, the likely primary conduits of change. Therefore, it is obviously a matter of concern for policymakers and economists due to its impact on the livelihoods.

Using the Ricardian approach, this study attempted to measure the impact of climate change on agriculture in which net farm income is regressed only with climate variables in Model 1 and then with both climate and other socio-economic variables. The explanatory variables include the linear and quadratic terms of precipitation and temperature for the four seasons (winter, spring, summer, and the fall), household variables, land, and ratio of irrigated land. The findings show significant impact of climate variables on net farm income per hectare across Nepalese farm households, indicating both positive and negative impact of precipitation and temperature. Net farm income is likely to be increased with low precipitation and high temperature during the fall and spring seasons which are the major harvesting seasons of Nepal. Farmers are likely to increase their revenue with relatively low temperature and enough precipitation during the summer season. Other socio-economic variables have also impact on net farm income. For instance, net farm income is likely to be high on irrigated farm land combined with obtaining farm credit. But small farms manage better and obtain higher net income per hectare than large farms.

The study also focused on the impact of climate change on agriculture using the Ricardian approach and some interesting results were obtained. As there is a variation in the impact of climate change (i.e. change in precipitation and temperature) on agriculture in different seasons and climatic zones, these variations need to be addressed while formulating adaptation and mitigation strategies of the negative impact of climate change in the country. Since, this study adopted only a Ricardian approach to measure the impact of climate change on agriculture, further study should be carried out using more advanced models, such as agronomic-economic and CGE models.

Acknowledgement

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References


Resource Use Efficiency in Vegetable Production in the High Hills of Eastern Nepal

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Abstract

The main purpose of this study was to analyze the resource use efficiency and factors influencing inefficiency in vegetable production in the high hills of Eastern Nepal. This study used secondary data set of Nepal vegetable crops survey (2010) collected by the Central Bureau of Statistics, Government of Nepal, and adopted the stochastic frontier analysis (SFA). The results from the maximum likelihood estimates revealed that the mean technical efficiency score was 0.79 which indicated high potential in increasing vegetable production from the existing resources and technology. The major contributing input factors for resource use efficiency were land, labour, seeds, compost, fertilizers, pesticides, and farm capital. The farm-specific factors such as seed types, credit access, and technical support significantly affected on inefficiency in vegetable production. The study recommends policies to focus on improving land, developing skilful labour, encouraging vegetable farmers to promote compost, easy access to farm capital, fertilizers and pesticides. Policies need to focus also on innovating and adopting improved seed varieties, easy access to credit facilities, and technical supports and backstopping to farmers, and encouraging women farmers in vegetable production.

Keywords: Resource use, efficiency, inefficiency, stochastic frontier, vegetable production

JEL Codes: Q1, Q12, J43

1. Introduction

Vegetable is an important component in Nepalese economy which provides huge employment, generates income and supplying plenty of nutrients for millions of people. Annually, the output was more than 3 million tons of vegetables in 0.24 million hectares of land with a fast growth rate (MOAD, 2012). Among the geographical regions in Nepal, the high-hills are less accessed with infrastructures, markets, extension services, and public incentives in vegetable production that imply relatively low level of production and productivity of vegetables. The major concern in Nepalese vegetable farming is limited resources available with the farmers, and inappropriate and inefficient use of these resources leading to chronic inefficiency in vegetable production. Labour is one of the important factors in vegetable production where all the farming activities are carried out by labour manually. Nepalese farmers use compost rather than chemical
fertilizers for plant nutrients since fertilizer is not available to the farmers in adequate quantity, and the quality is also not certain. Therefore, it becomes important to analyse the impact of composts and chemical fertilizers on vegetable production. Parikh, Ali, and Shah (1995); Udoh (2005); and Udoh, and Etim (2007) found that both of these inputs contributed significantly in agriculture production. Farmers use pesticide in vegetable farming which is quite expensive, not available on time, and also the quality is in doubt. Besides these inputs, other expenditures are incurred by farmers on items such as simple equipment, construction of temporary plastic-bamboo tunnels, thatch etc., considered as farm capital. Resource use efficiency is the capacity of resource to produce the highest level of output, and technical efficiency deals with the capacity of farm to produce the optimum level of output with given level of inputs. It goes without saying that improving efficiency of resources would increase both the production, and productive efficiency of vegetables.

Vegetable farming in Nepal is also strongly affected by farm-specific factors such as seed types, credit accessible to farmers, technical support, the education level of the head of household, and sex of household head. Previous studies of Bozoğlu (2007); Donkoh (2013); and Nwauwa, Rahji, and Adenegan (2013) used these variables and reported that they had a significant role in vegetable production. Therefore, these variables were also used in this study to analyse their influence on inefficiency in vegetable production. A great deal of empirical studies have been carried out using stochastic frontier analysis in vegetable production, although resource use efficiency in vegetable farm has not been conducted in Nepal. Therefore, the main purpose of this study was to analyse resource use efficiency and determine factors influencing inefficiency in vegetable production in high hills of Eastern Nepal. This study may help in formulating policies for prioritizing inputs and making vegetable farms more efficient.

2. Materials and Methods

2.1 Study Area

The study was conducted in Sankhuwasabha district which is located in the high hill region of Eastern Nepal. The study area included Khandawari municipality and 6 Village Development Committees (VDCs) such as Baneshowar, Chainpur, Dhupu, Diding, Mamling, and Syabun. The elevation range of the district is 345 - 8470 meters, while the study area ranges from 1500 to 2500 meters above the sea level. The reason for selecting this district was its high contribution in vegetable production among eastern high hill districts, where vegetable production accounted for 13,875 tons in 1,470 hectares of land with 9.44 tons/ha of productivity in 2011 (MOAD, 2012). The common vegetable crops are tomato, cauliflower, cabbage, broad leaf mustard, onion, potato, radish, pumpkin, gourds, cucumber, chili, bean, eggplant, squash, etc. The majority of farmers cultivate vegetable in subsistence level; however, the production areas in the nearby district headquarters are commercially oriented. The study area is characterized by underdeveloped infrastructure, the seasonal road is linked to the district headquarters of Dhankuta district, inputs available only in the district headquarter, the extension service is not
effective, credit facility is not well accessed, and the people sell their products only in weekly markets.

2.2 Data Set

This study used secondary datasets of Nepal Vegetable Crops Survey (2009/10) of the Central Bureau of Statistics (CBS), the Government of Nepal. A total of 956 sample vegetable farms of 150 households were used where the farm sizes were equal and larger than 0.001 hectares. The output in rupees (Rs.)\(^{24}\) was as the dependent variable, calculated by adding household consumption, farm use, sales, and charity. The explanatory variables such as land, labour, seeds, compost, fertilizers, pesticides, and farm capital were considered in estimating frontier production function. The land was calculated in hectares, and labour (hired and family), seeds, compost, fertilizers, and pesticides were calculated in cost, while farm capital was estimated as aggregate expenses in plastic-bamboo temporary tunnel, thatch, equipments, etc.

Farm-specific variables used were seed type dummy 1 if improved seed adopted and 0 otherwise; credit accessed dummy 1 if the farmer accessed credit and 0 otherwise; technical support dummy 1 if the farm accessed technical support and 0 otherwise; years of education of head of household; and sex of household head dummy 1 if the farm headed by male and 0 otherwise. Alene (2008); Binam, et al. (2004); Nwauwa et al. (2013); Ojo (2009); Rahman (2003); and Tiedemann and Latacz-Lohmann (2013) used these variables in their research, and the results were consistent and significantly influencing agriculture production.

2.3 Stochastic Frontier Analysis

The study adopted stochastic frontier analysis (SFA), version 4.1, developed by Coelli (1996). One stage procedure was adopted to measure the unknown parameter and for determining farm-specific factors influencing inefficiency in vegetable production (equation 1).

\[
\ln(Y_i) = \ln(X_i)\beta + v_i - u_i \quad i = 1 \ldots n
\] (1)

Where, \(Y_i\) is production value of the \(i\)th farm, \(X_i\) is vector of inputs for \(i\)th farm, \(\beta\) is coefficient of unknown parameters, \(\ln\) is natural logarithm. The random error \((v_i)\) assumed to be independently and identically distributed with \(N(0,\delta_v^2)\) while \(u_i\) represents non-negative random error account for technical inefficiency in production, and assumed to be independently distributed as truncations at zero of the \(N(\mu_i, \delta_u^2)\).

The inefficiency effect model was defined as \(U_i = z_i\delta\), where \((z_i)\) for farm-specific explanatory variables that influence technical inefficiency of a farm and \((\delta)\) is unknown parameter to be estimated. Empirical model of stochastic production function was derived (equation 2), where the output of vegetables were considered as the function of land, labour, seeds, compost, fertilizers, pesticides, and farm capital (equation 2).

\(^{24}\) Rs is Nepali currency with Rs 80.0 equalling 1 US$ in 2010.
Technical inefficiency was considered as a function of five farm-specific variables such as seed types, credit accessed, technical support, education level of the head of household, and the sex of household head to analyse the influence of these variables on inefficiency of vegetable production (equation 3).

\[ u_i = \delta_0 + \delta_1 \text{Seed type}_i + \delta_2 \text{Credit}_i + \delta_3 \text{Technical support}_i + \delta_4 \text{Education}_i + \delta_5 \text{Sex}_i \]  

3. Results and Discussions

3.1 Descriptive Statistics of Variables

The descriptive statistics of the variables used in this study is presented in Table 1. The farm sizes of vegetable farming were quite small where average size being 0.007 hectare. Majority of the farmers (57%) in the study area used local varieties of vegetable seeds. A limited number of farmers (40%) accessed credit facility because of the financial institutions are concentrated in the city areas. The large number of farmers (87%) accessed technical support provided by the government or non-governmental institutions. This indicated that farmers are getting technical services, although it is not effective in disseminating technology. Additionally, the level of education of vegetable farmers was quite low; the average education of sample farmers was 3 years; and about 30 percent of the farmers had a zero level of education. Moreover, the majority of vegetable farms were headed by male farmers which was estimated to be 93 percent.

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Farm size</td>
<td>0.007</td>
<td>0.000</td>
<td>0.001</td>
<td>0.161</td>
</tr>
<tr>
<td>Labor cost (Rs)</td>
<td>234.198</td>
<td>139.323</td>
<td>70.000</td>
<td>990.000</td>
</tr>
<tr>
<td>Seed cost (Rs)</td>
<td>106.856</td>
<td>97.118</td>
<td>5.000</td>
<td>750.000</td>
</tr>
<tr>
<td>Compost cost (Rs)</td>
<td>124.095</td>
<td>79.089</td>
<td>10.000</td>
<td>700.000</td>
</tr>
<tr>
<td>Fertilizer cost (Rs)</td>
<td>48.222</td>
<td>136.574</td>
<td>0.000</td>
<td>1200.000</td>
</tr>
<tr>
<td>Pesticide cost (Rs)</td>
<td>29.984</td>
<td>91.571</td>
<td>0.000</td>
<td>800.000</td>
</tr>
<tr>
<td>Farm capital (Rs)</td>
<td>129.555</td>
<td>86.935</td>
<td>10.000</td>
<td>800.000</td>
</tr>
<tr>
<td>Seed type</td>
<td>0.429</td>
<td>0.495</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Credit accessed</td>
<td>0.394</td>
<td>0.489</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Technical support</td>
<td>0.873</td>
<td>0.333</td>
<td>0.000</td>
<td>1.000</td>
</tr>
<tr>
<td>Education (year)</td>
<td>3.409</td>
<td>2.800</td>
<td>0.000</td>
<td>9.000</td>
</tr>
<tr>
<td>Sex of household head</td>
<td>0.934</td>
<td>0.248</td>
<td>0.000</td>
<td>1.000</td>
</tr>
</tbody>
</table>

3.2 Maximum Likelihood Estimates of Vegetable Farms
The results of maximum likelihood estimates (MLE) are presented in Table 2. The mean of technical efficiency was 0.79, which indicated that there was more scope in increasing vegetable production without increasing additional input resources. The variance parameters were highly significant, and indicated that vegetable production was affecting by technical inefficiency. Gamma ($\gamma$) was highly significant and estimated coefficient 0.69, revealing that a large portion of inefficiency (69%) was as a result of technical inefficiency which can be improved by proper vegetable production management practices. The result of likelihood-ratio (LR) test$^{25}$ revealed that the null hypothesis of technical efficiency strongly rejected, and further proving that technical inefficiency existed.

The estimated coefficients of all the independent input variables were highly significant with consistent signs (Table 2). The elasticity of parameters were 0.038, 0.327, 0.147, 0.156, 0.036, 0.044, and 0.223 for land, labour, seed, compost, fertilizer, pesticide, and farm capital, respectively, and the highest elasticity was observed in labour, farm capital, compost, and seed. The sum of the elasticity was 0.97, indicating decreasing returns to scale in vegetable production in the study area.

Among farm-specific variables, seed type negatively affected on inefficiency of vegetable production which indicated that improved seed would have a positive impact on the production efficiency of vegetables. The credit access to the vegetable farmers negatively affected to inefficiency in vegetable production which was significant at 10 percent level, indicated that access of credit to the vegetable farmers would have a positive impact on production efficiency. Similar result was found by Bozoğlu (2007) for vegetable production in Turkey, and Binam et al. (2004) for groundnut and maize in Cameroon. The negative effect of technical support in inefficiency of vegetable production revealed that providing technical support would improve production efficiency in vegetables farming. The education and sex of household head were insignificant in influencing vegetable production, although the sex of household head showed a consistent expected sign. The negative effect of sex on inefficiency indicated that women farmers were more efficient than men.

---

$^{25}$ The likelihood-ratio test statistic, $\lambda = -2[\ln(likelihood(\lambda_0)) - \ln(likelihood(\lambda_1))]$, has an approximately Chi-square distribution with parameter equal to the number of parameters assumed to be zero in the null hypothesis ($H_0$), provided.
Table 2: Results of maximum likelihood estimates of vegetable farms

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Standard Error</th>
<th>t-ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Production function</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.287</td>
<td>0.188</td>
<td>15.286***</td>
</tr>
<tr>
<td>Ln (land)</td>
<td>0.038</td>
<td>0.013</td>
<td>2.941***</td>
</tr>
<tr>
<td>Ln (Labor)</td>
<td>0.327</td>
<td>0.0201</td>
<td>16.222***</td>
</tr>
<tr>
<td>Ln (Seed)</td>
<td>0.147</td>
<td>0.014</td>
<td>10.211***</td>
</tr>
<tr>
<td>Ln (Compost)</td>
<td>0.156</td>
<td>0.014</td>
<td>10.87***</td>
</tr>
<tr>
<td>Ln (Fertilizer)</td>
<td>0.036</td>
<td>0.014</td>
<td>2.464***</td>
</tr>
<tr>
<td>Ln (Pesticide)</td>
<td>0.044</td>
<td>0.0162</td>
<td>2.723***</td>
</tr>
<tr>
<td>Ln (Farm capital)</td>
<td>0.223</td>
<td>0.015</td>
<td>15.312***</td>
</tr>
<tr>
<td>Sum of elasticity</td>
<td>0.971</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Variance parameters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sigma-square</td>
<td>0.142</td>
<td>0.0109</td>
<td>13.026***</td>
</tr>
<tr>
<td>Gamma</td>
<td>0.692</td>
<td>0.0456</td>
<td>15.188***</td>
</tr>
<tr>
<td>LR test</td>
<td>37.131</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TE</td>
<td>0.795</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Inefficiency effect model</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seed type</td>
<td>-0.049</td>
<td>0.021</td>
<td>-2.377***</td>
</tr>
<tr>
<td>Credit accessed</td>
<td>-0.045</td>
<td>0.0209</td>
<td>-2.171**</td>
</tr>
<tr>
<td>Technical support</td>
<td>-0.046</td>
<td>0.029</td>
<td>-1.597*</td>
</tr>
<tr>
<td>Education level of head of household</td>
<td>0.004</td>
<td>0.003</td>
<td>1.229</td>
</tr>
<tr>
<td>Sex of household head</td>
<td>-0.042</td>
<td>0.037</td>
<td>-1.131</td>
</tr>
</tbody>
</table>

***, **, *, NS indicates significant at 1%, 5%, 10%, and non-significant levels respectively.

4. Conclusions and Policy Implications

The main purpose of this study was to analyze resource use efficiency and factors influencing inefficiency in vegetable production in the high hills of Eastern Nepal. The result of maximum likelihood estimates revealed the average technical efficiency of 0.79, which indicated that there was good opportunity to increase vegetable production within the existing level of input resources. The variance parameter, particularly the coefficient of gamma 0.69 indicated that more than half of the inefficiency was due to technical inefficiency, implying that production could be increased by improving farm management practices.

Input variables such as land, labour, seeds, compost, fertilizers, pesticides and farm capital were highly significant, and the expected signs were consistent. Meanwhile, higher elasticity was found in labour, farm capital, compost, and seed. Therefore, the study recommends policies to be focused on capacity development of agriculture labour to make them skilful; easy access of farm capital to vegetable farmers; vegetable farmers to be encouraged for using compost for plant nutrients; innovation and dissemination of improved seed varieties of vegetables that are insect-
pest resistant and high yielding; improvement of land quality; and easy availability and affordability of pesticides, and fertilizers to the farmers.

In the inefficient effect model, the negative effect of seed type on the inefficiency of vegetable productions suggested that policy needs to be focused on developing improved seeds of vegetables that can increase vegetable production efficiency. Credit access was significant in influencing vegetable production, implying that financial institutions need to be established in rural areas that would help farmers in providing credit necessary for vegetable production. One of the important results was the negative effect of technical support in the inefficiency of vegetable production, indicating that providing technical support to vegetable farmers would help to increase the total value of vegetable production. This implied that policies should focus on dissemination of technology by providing training and observation tour, and regular visits of technicians to the vegetable farms. Furthermore, the consistency in the expected sign of the sex of the household head implied that women farmers need to be encouraged in vegetable farming by providing them necessary training, technical backstopping, and policy incentives that would help to increase vegetable production.

References


Crop Yield Responses to Climate Change in the Tropical Region of Nepal

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Abstract

The empirical relationships between crop yield and climate variables are important for predicting agricultural production. The study assesses the effects of climate variables on crop yield and the uniformity of effects across crops, growing seasons, and locations in Nepal. The research covers three districts in the tropical region of Nepal, and considers four major food crops as paddy, maize, wheat, and potato. The data represent the observed district level averages on crop yield and climate variables (rainfall, maximum temperature, and minimum temperature) between 1975 and 2011. A multivariate regression analysis, based on the first difference time series of crop yield and climate variables, is employed to estimate the empirical relationships between crop yield and climate variables. The regression results show that climate variables significantly influence the crop yield, but not uniformly on all crops and in all growing seasons and districts. Increase or decrease of maximum and minimum temperature shows heterogeneous effects on the yield of some crops. Deviations of climate variables within growing seasons also show heterogeneous effects on crop yield. The study concludes that climate variables and their deviations within the growing seasons are the important determinants of crop yield. The effects of climate variables on crop yield depend on crop types, growing seasons, and locations. The effects can be significantly positive or negative or insignificant.

Key words: Climate change, Climate variables, Crop yield, Regression analysis

JEL classification: C32, Q10, Q54

1. Introduction

Variations in climatic conditions are associated with the variability of crop yield (Kim and Pang, 2009; Ines and Hansen, 2006; Hoogenboom, 2000). Climate change affects crop growth and development, due to changes in the mean and variability of temperature and rainfall (Challinora and Wheeler, 2008). Temperature rise and rainfall variation cause drought, flood, landslide, and soil degradation that lead to declining global agricultural productivity (IPCC, 2007). The year-to-year variability of rainfall and temperature is the primary source of agricultural production risk that causes uncertainty in crop yield (Cabas et al., 2010; Park and Sinclair, 1993). Farmers face
variable income from year to year primarily because of variable weather conditions, diseases, and pests (Pannell et al., 2000; Berbel, 1993; Fleisher, 1990). There is no uniformity in the direction and magnitude of climate variable effects on crops (Granger, 1980).

There is the likelihood of an asymmetric change in temperature where nighttime temperature increase is greater than the daytime temperature increase (Nagarajan et al., 2010; Lobell and Ortiz-Monasterio, 2007; Dhakhwa and Campbell, 1998; Rosenzweig and Tubiello, 1996). Higher variability in temperature (higher maximum and lower minimum) negatively affects the yield of several crops (McCarl et al., 2008). For example, the nighttime temperature increase beyond 22°C significantly adversely affects grain yield and quality in rice and reduction in spikelet fertility and grain weight per plant accounts for the decline in rice yield (Nagarajan et al., 2010). The high temperature for a short period can affect the quantity and quality of wheat yield (Stone and Nicolas, 1995).

The impacts of climate change are severe in developing countries because they have rain-fed farming systems and weak capabilities in their technological adaptation (Ogallo et al., 2000). Rain-fed agriculture is likely to be affected adversely by climate change (Pant, 2009). Because of high dependence on the agricultural sector, loss of agricultural productivity due to climate change significantly affects the economy of many developing countries (Gebreegziabhier et al., 2011). The impacts of climate change have already been noticed in the agricultural sector in Nepal. Nepalese agriculture is rain-fed and relies mainly on weather patterns, so even small and short period weather extremities adversely affect the production. The agricultural sector dominates Nepalese economy; the contribution of agriculture and forestry sectors to total Gross Domestic Product (GDP) over 2000/01 to 2011/12 is 34.5% on average (MoAD, 2013). Agricultural dependence makes the economy sensitive to climate variability (World Bank, 2002).

The impact of climate change on crop yield is an important field of conducting research. The existing literature informs about the overall impact of climate change and requirements for suitable coping strategies to develop the agricultural sector. Previous studies (e.g. Welch et al., 2010; McCarl et al., 2008; Sheehy et al., 2006; Chen et al., 2004) suggest that there are heterogeneous effects of climate variables on crop yield that depend on crop types, growing seasons, and regions. However, these studies mainly consider large scales and generalize the climate variables’ effects on crop yield and the effects depend on crop types and geographic regions. The existing studies do not cover the assessments of the intra-regional site-specific variations of the impacts of climate change on crop yield. Spatial patterns of climate and their effects on crop yield are essential to identify vulnerability and determine the suitable regional agricultural adaptive strategies to climate change (Tao et al., 2008). A better understanding of the empirical relationships between crop yield and climate variables is essential for implementing adaptation to climate change in agriculture (OECD, 2012).

There are few studies in Nepal (e.g. Poudel and Kotani, 2012; Joshi et al., 2011; Malla, 2008) that empirically evaluate the effects of climate variables on crop yield. Malla (2008) analyzes the relationships between climate scenarios (elevated temperature and CO2) and agriculture, which is based on data generated in a controlled experimental condition. Joshi et al. (2011) assess the
relationships between crop yield and climate variables by using time series analysis, but their study does not cover the heterogeneity of climate change impacts on crop yield across spatial dimensions within Nepal and has limitations in capturing the effects of the intra-seasonal variations of climate variables on crop yield. Poudel and Kotani (2012) assess the relationships between crop yield and climate variables and the heterogeneity of impacts across growing seasons and altitudes in the central region of Nepal, but do not assess the heterogeneity of climate change impacts on crop yield within geographic regions and their study has limitations in capturing the effects of day versus night temperature on crop yield.

This study evaluates the empirical relationships between crop yield and corresponding growing seasonal climate variables in different sites within a tropical region of Nepal. The study assesses the impacts of growing seasonal climate variables on yield of the major food crops (paddy, maize, wheat, and potato) across crop types, growing seasons, and locations and adds information and insight to the existing literature of climate change impacts on Nepalese agriculture. The findings are useful for estimating climate variable effects on crop yield and the most vulnerable crops for prioritizing strategies for adapting to climate change.

2. Methods and Data

2.1 Regression Analysis

Application of regression models to predict crop yield changes due to changes in climate variables, based on historical data on crop yield and climate variables, is common (Poudel and Kotani, 2012; Joshi et al., 2011; Welch et al., 2010; Lobell and Burke, 2010; Schlenker and Lobell, 2010; You et al., 2009; Kim and Pang, 2009; Schlenker and Roberts, 2009; Tao et al., 2008; McCarl et al., 2008; Tannura et al., 2008; Lobell, 2007; Lobell and Field, 2007; Iglesias and Quiroga, 2007; Sheehy et al., 2006; Tao et al., 2006; Schlenker and Roberts, 2006; You et al., 2005; Chen et al., 2004; Chang, 2002; Nicholls, 1997; Granger, 1980). The regression model using observed data of crop yield and climate variables is based on time series or panel or cross-section data. In this study, a multivariate time series regression model is employed. The primary advantages of the time series regression model over the panel and cross-section models are to capture the behavior specific to the given area and control the errors from omitted variables such as crop management and soil quality that vary spatially (Lobell and Burke, 2010). A common approach (Joshi et al., 2011; Tao et al., 2008; Lobell, 2007; Lobell and Field, 2007) based on the first difference time series (difference in values from one year to the next) for yield and climate variables is used. It is assumed that crop yield responds to year-to-year changes of climate variables, and use of the first difference time series of the crop yield helps to remove the non-climatic influences such as adoption of new varieties and changes in crop management practices (Joshi et al., 2011; Lobell, 2007; Lobell and Field, 2007).

This study considers the widely used climate variables as rainfall and temperature to assess the impacts of climate change on the crop yield. Both maximum and minimum air temperatures are considered to assess the effects (direction and magnitude) of the day and night temperature on crop yield, assuming difference in the influence of day versus night temperature on crop.
Maximum and minimum temperature can impact differently in different crops and on different regions; temperature increase during the day can have different effects on the crop than temperature increase during the night. The understanding of the effects of temperature during the day and night on crop yield is necessary because warming trend during the day and night differs; minimum temperature has been rising faster than the maximum temperature in some Asian countries (Welch et al., 2010). In most regions, maximum temperature increase is more harmful to crop yield than minimum temperature increase (Lobell, 2007).

Rather than using annual average data of rainfall and temperature, crop-specific growing seasonal averages are used to make the regression results realistic. Consideration of the growing seasonal average for each climate variable for each crop produces the best-fit model $R^2$ (Lobell and Field, 2007). This study considers the total growing seasonal rainfall, average growing seasonal maximum and minimum temperatures, and standard deviations of monthly rainfall and temperature within the growing season. The standard deviations of rainfall and temperature were included in the regression model to assess the intra-seasonal effects of climate variables on crop yield. The standard deviations of monthly rainfall and temperature within a growing season were considered on the basis that sub-seasonal variations (e.g. long dry period, intense rainfall) are critical to crop growth.

The Ordinary Least Square (OLS) method was used to estimate the contribution of climate variables to crop yield. The Stata (statistical software) was used to run the regression model. The multiple regression function estimated in the study is expressed as (Gujarati, 2004):

$$Y_i = \beta_0 + \beta_1X_{1i} + \beta_2X_{2i} + \ldots + \beta_kX_{ki} + \varepsilon_i$$  \hspace{1cm} (1)

Or,

$$Y_i = \beta_0 + \sum_{n=1}^{k} \beta_nX_{ni} + \varepsilon_i$$  \hspace{1cm} (2)

Where, $i$ = the $i$th observation. $Y_i$ (dependent variable) is the annual change in crop yield ($Y_t - Y_{t-1}$); $\beta_0$ is the constant term (intercept term); $\beta_0$ is the average value of $Y_i$ when the predictor variables ($X_{1i}, X_{2i}, \ldots, X_{ki}$) are set equal to zero; $\beta_{1-k}$ are the regression coefficients; $X_{1i-k}$ are the independent variables, which are the annual changes in crop-specific growing seasonal climate variables; and $\varepsilon_i$ is the model prediction error (stochastic disturbance term).

More specifically, the regression model developed for this study is:

$$\Delta\text{CropYield}_i = \beta_0 + \beta_1\Delta\text{Rain}_i + \beta_2\Delta\text{Tmax}_i + \beta_3\Delta\text{Tmin}_i + \beta_4\Delta\text{StDevRain}_i +\beta_5\Delta\text{StDevTmax}_i + \beta_6\Delta\text{StDevTmin}_i + \varepsilon_i$$  \hspace{1cm} (3)

Where,

$$\Delta\text{CropYield} = f(\Delta\text{Rain}, \Delta\text{Tmax}, \Delta\text{Tmin}, \Delta\text{StDevRain}, \Delta\text{StDevTmax}, \Delta\text{StDevTmin})$$  \hspace{1cm} (4)
Figure 1 presents the sequential steps followed in the regression analysis. First, spatial and growing seasonal averages of the crop yield and the climate variables were estimated, followed by estimation of the first difference time series (year-to-year changes). Then the co-linearity among predictor variables (climate variables) was checked, which is essential for interpreting the regression results (Welch et al., 2010; Sheehy et al., 2006). Correlations among climate variables allow considering the presumed climate variables in the regression model. The response variable in the regression model is the first difference in the crop yield (ΔCropYield), and the predictor variables are the first differences in total growing seasonal rainfall (ΔRain), average growing seasonal maximum temperature (ΔTmax), average growing seasonal minimum temperature (ΔTmin), standard deviation of monthly rainfall within the growing season (ΔStDevRain), standard deviation of monthly maximum temperature within the growing season (ΔStDevTmax), and standard deviation of monthly minimum temperature within the growing season (ΔStDevTmin).

2.2 Study Area and Data

The geographic divisions of Nepal include three regions as mountain, hill, and Tarai. The research represents the Tarai region of Nepal, representing three locations (west, center, and east). The Tarai region of Nepal holds large shares in the national agricultural production of the total land holding in Tarai. 34% is under cultivation, which accounts for 56% of the total cultivated land in the country (CBS, 2008). The Tarai lies in the low altitude region in the south of Nepal, which is flat, has a tropical climate and is most vulnerable to climate change (Alam and Murray, 2005). In recent years, Tarai has witnessed an increase in frequency of erratic rainfall, floods, drought, heat waves, cold waves, and hailstorms and has the greatest risk of flooding that reduces agricultural productivity and disrupts economic activities (Dulal et al., 2010). In such a
context, this study covers three districts (one in each location): Banke (west), Chitwan (center) and Morang (east) in Tarai. Four major food crops -paddy, maize, wheat, and potato - (Subedi, 2003) are considered.

The data represents secondary data, observed crop yield, and climate variables, obtained from the government offices in Nepal. Based on the availability of crop yield and climate data, the data used in the regression model cover the period from 1976/77 to 2010/11 for Banke (35 observations), from 1980/81 to 2010/11 for Chitwan (31 observations), and from 1975/76 to 2009/10 for Morang (35 observations). The sections that follow by brief offer explanations on the crop yield and climate data.

**Crop Yield**

The time series data on crop yield (district averages) were compiled from different publications such as statistical information on Nepalese agriculture by the Agri-Business Promotion and Statistics Division (ABPSD) of the Ministry of Agricultural Development (MoAD). The crop yield data follow the country’s accounting period (fiscal year). Nepal’s fiscal year (FY) begins from 16 July of the preceding year and ends on 15 July of the succeeding year for the country’s accounting period of twelve months. The crop yield data represent the district average, which is the annual average of its growing seasons. In the study districts, paddy and maize are grown in summer and spring seasons, and wheat and potato in the winter season.

Time has a positive influence on crop yield because technological progress and crop management improvements occur over time (year). The crop yield observed in the study districts also increases over time; however, there are high fluctuations in the crop yield over the years. High variation in climate patterns could be one of the causes of crop yield fluctuations. Figures 2, 3, and 4 present the trends of paddy, maize, wheat, and potato yield from 1975/76 to 2010/11 in Banke, Chitwan, and Morang respectively.
Figure 2: Annual average of crop yield in Banke
(Source: MoAD, 1975/76-2010/11)

Figure 3: Annual average of crop yield in Chitwan
(Source: MoAD, 1975/76-2010/11)
Climate Variables

The data obtained on rainfall and temperature from various weather (meteorological) stations were provided from the Department of Hydrology and Meteorology (DHM) of the Ministry of Environment (MoE). The data are for twelve months of a common year from January to December. The monthly data on rainfall, maximum temperature, and minimum temperature were from thirteen meteorological stations in the study districts (Banke7, Chitwan3, Morang3). District-wise averages of monthly rainfall and temperature were estimated by grouping available monthly data from the meteorological stations of each district.

Total growing seasonal rainfall and average growing seasonal maximum and minimum temperatures were considered in the regression analysis. Rainfall and temperature data were defined and separated for the three growing seasons (summer, winter, and spring) in a year. The summer season includes the months from July to October, the winter from November and December of the preceding year -January to February of the succeeding year, and the spring season includes the months from March to June. Monthly rainfall and temperature were considered to estimate seasonal rainfall and temperature. Total growing seasonal rainfall was obtained by adding the rainfall of four months in a growing season. The average growing seasonal temperature was obtained by taking an average of four months in a growing season. The population standard deviation was considered to calculate the standard deviations of monthly rainfall and temperature within the growing season.

Table 1 presents the summer, winter, and spring seasonal characteristics of rainfall and temperature and comparisons of their means among the study districts. Though all three districts
represent the tropical region of Nepal, there are significant differences in the rainfall and temperature observed among the districts. Therefore, regression analysis for each crop across the study districts was done to assess the site-specific climatic impacts on crop yield.

**Table 1: Characteristics of the growing seasonal climate variables in the study districts**

<table>
<thead>
<tr>
<th>Climate variables</th>
<th>Growing season</th>
<th>Statistics</th>
<th>Banke</th>
<th>Chitwan</th>
<th>Morang</th>
<th>Comparing means</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total seasonal rainfall (mm)</td>
<td>Summer</td>
<td>Average s. d.</td>
<td>1,022.13</td>
<td>1,390.70</td>
<td>1,370.67</td>
<td>17.739</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>Average s. d.</td>
<td>63.35</td>
<td>55.73</td>
<td>44.43</td>
<td>1.786</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>Average s. d.</td>
<td>285.49</td>
<td>568.44</td>
<td>575.86</td>
<td>44.259</td>
</tr>
<tr>
<td>Seasonal maximum temperature (˚C)</td>
<td>Summer</td>
<td>Average s. d.</td>
<td>32.70</td>
<td>32.88</td>
<td>31.96</td>
<td>27.953</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>Average s. d.</td>
<td>24.48</td>
<td>25.38</td>
<td>25.81</td>
<td>26.136</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>Average s. d.</td>
<td>35.43</td>
<td>34.43</td>
<td>32.75</td>
<td>89.112</td>
</tr>
<tr>
<td>Seasonal minimum temperature (˚C)</td>
<td>Summer</td>
<td>Average s. d.</td>
<td>23.82</td>
<td>23.58</td>
<td>24.22</td>
<td>11.177</td>
</tr>
<tr>
<td></td>
<td>Winter</td>
<td>Average s. d.</td>
<td>10.08</td>
<td>10.13</td>
<td>11.39</td>
<td>27.905</td>
</tr>
<tr>
<td></td>
<td>Spring</td>
<td>Average s. d.</td>
<td>20.41</td>
<td>19.66</td>
<td>21.05</td>
<td>29.895</td>
</tr>
</tbody>
</table>


3. Results and Discussion

3.1 Crop Yield-Climate Relationship

The results of regression show that climate variables play a significant role in predicting crop yield. However, the direction and magnitude of relationships between crop yield and climate variables vary substantially. The relationships which could be significantly positive, negative or insignificant, depend on the existing trends of climate variables in the study districts. The regression model shows the variation in crop yield due to climate variables ranges from 12% (spring maize in Morang) to 61% (summer rice in Banke). In three districts, considering three significance levels 1%, 5%, and 10%, three (16.6%) have rainfall coefficient significant, five (27.7%) have maximum temperature coefficient significant, three (16.6%) have minimum temperature coefficient significant, four (22.2%) have s. d. of rainfall coefficient significant, five (27.7%) have s. d. of maximum temperature coefficient significant, and five (27.7%) have s. d. of minimum temperature coefficient significant (tables 2, 3, and 4). These observations underscore the absolute importance of variations in climate variables for year-to-year changes in crop yield.
### Table 2: Regression coefficients of growing seasonal climate variables for paddy yield

<table>
<thead>
<tr>
<th>ΔClimate variable</th>
<th>ΔPaddy yield in summer season (ton/ha)</th>
<th>ΔPaddy yield in spring season (ton/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Banke</td>
<td>Chitwan</td>
</tr>
<tr>
<td>ΔTotal seasonal rainfall (mm)</td>
<td>0.00049</td>
<td>0.00026</td>
</tr>
<tr>
<td></td>
<td>(0.00055)</td>
<td>(0.00024)</td>
</tr>
<tr>
<td>ΔAverage seasonal maximum temperature (°C)</td>
<td>-0.70328**</td>
<td>-0.07487</td>
</tr>
<tr>
<td></td>
<td>(0.26248)</td>
<td>(0.12879)</td>
</tr>
<tr>
<td>ΔAverage seasonal minimum temperature (°C)</td>
<td>0.26602*</td>
<td>0.11972</td>
</tr>
<tr>
<td></td>
<td>(0.14410)</td>
<td>(0.15900)</td>
</tr>
<tr>
<td>As. d. of rainfall (mm)</td>
<td>0.00027</td>
<td>-0.00033</td>
</tr>
<tr>
<td></td>
<td>(0.00194)</td>
<td>(0.00104)</td>
</tr>
<tr>
<td>Δs. d. of maximum temperature (°C)</td>
<td>-0.74165**</td>
<td>-0.27430</td>
</tr>
<tr>
<td></td>
<td>(0.32051)</td>
<td>(0.19579)</td>
</tr>
<tr>
<td>Δs. d. of minimum temperature (°C)</td>
<td>0.04342</td>
<td>0.12455</td>
</tr>
<tr>
<td></td>
<td>(0.24139)</td>
<td>(0.18249)</td>
</tr>
</tbody>
</table>

Model fit (R²): 0.61, 0.17, 0.14, 0.37, 0.13, 0.31

Note: Numbers in parentheses are standard errors. Statistical significance: *** at 1% level, ** at 5% level, * at 10% level

### Table 3: Regression coefficients of growing seasonal climate variables for maize yield

<table>
<thead>
<tr>
<th>ΔClimate variable</th>
<th>ΔMaize yield in summer season (ton/ha)</th>
<th>ΔMaize yield in spring season (ton/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Banke</td>
<td>Chitwan</td>
</tr>
<tr>
<td>ΔTotal seasonal rainfall (mm)</td>
<td>0.00002</td>
<td>0.00039**</td>
</tr>
<tr>
<td></td>
<td>(0.00033)</td>
<td>(0.00017)</td>
</tr>
<tr>
<td>ΔAverage seasonal maximum temperature (°C)</td>
<td>-0.35039**</td>
<td>-0.01218</td>
</tr>
<tr>
<td></td>
<td>(0.15787)</td>
<td>(0.09359)</td>
</tr>
<tr>
<td>ΔAverage seasonal minimum temperature (°C)</td>
<td>0.06862</td>
<td>0.25913**</td>
</tr>
<tr>
<td></td>
<td>(0.08666)</td>
<td>(0.11554)</td>
</tr>
<tr>
<td>Δs. d. of rainfall (mm)</td>
<td>-0.00230**</td>
<td>-0.00202**</td>
</tr>
<tr>
<td></td>
<td>(0.00116)</td>
<td>(0.00075)</td>
</tr>
<tr>
<td>Δs. d. of maximum temperature (°C)</td>
<td>-0.62549***</td>
<td>-0.18606</td>
</tr>
<tr>
<td></td>
<td>(0.19277)</td>
<td>(0.14227)</td>
</tr>
<tr>
<td>Δs. d. of minimum temperature (°C)</td>
<td>0.30109**</td>
<td>0.21821</td>
</tr>
<tr>
<td></td>
<td>(0.14518)</td>
<td>(0.13261)</td>
</tr>
</tbody>
</table>

Model fit (R²): 0.37, 0.38, 0.16, 0.30, 0.16, 0.12

Note: Numbers in parentheses are standard errors. Statistical significance: *** at 1% level, ** at 5% level

### Table 4: Regression coefficients of growing seasonal climate variables for wheat and potato yields

<table>
<thead>
<tr>
<th>ΔClimate variable</th>
<th>ΔWheat yield in winter season (ton/ha)</th>
<th>ΔPotato yield in winter season (ton/ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Banke</td>
<td>Chitwan</td>
</tr>
<tr>
<td>ΔTotal seasonal rainfall (mm)</td>
<td>-0.00046</td>
<td>0.00057</td>
</tr>
<tr>
<td></td>
<td>(0.00110)</td>
<td>(0.00125)</td>
</tr>
<tr>
<td>ΔAverage seasonal maximum temperature (°C)</td>
<td>0.09122**</td>
<td>-0.03292</td>
</tr>
<tr>
<td></td>
<td>(0.04266)</td>
<td>(0.04535)</td>
</tr>
<tr>
<td>ΔAverage seasonal minimum temperature (°C)</td>
<td>-0.04230</td>
<td>-0.04829</td>
</tr>
<tr>
<td></td>
<td>(0.03861)</td>
<td>(0.03908)</td>
</tr>
<tr>
<td>Δs. d. of rainfall (mm)</td>
<td>0.01092**</td>
<td>-0.00029</td>
</tr>
<tr>
<td></td>
<td>(0.00514)</td>
<td>(0.00426)</td>
</tr>
<tr>
<td>Δs. d. of maximum temperature (°C)</td>
<td>0.10338*</td>
<td>0.04266</td>
</tr>
<tr>
<td></td>
<td>(0.05500)</td>
<td>(0.05683)</td>
</tr>
<tr>
<td>Δs. d. of minimum temperature (°C)</td>
<td>0.02746</td>
<td>0.03739</td>
</tr>
<tr>
<td></td>
<td>(0.06478)</td>
<td>(0.05682)</td>
</tr>
</tbody>
</table>

Model fit (R²): 0.26, 0.22, 0.16, 0.41, 0.32, 0.27

Note: Numbers in parentheses are standard errors. Statistical significance: ** at 5% level, * at 10% level
In Banke, climate variables significantly affect paddy (summer), maize (summer), and wheat yields. The regression results show that temperature increase would drastically reduce paddy yield in Banke. Increased temperature could decrease paddy yield due to spikelet sterility and higher respiration loss (Wassmann et al., 2009). Climate variables significantly affect maize yield (summer) in Chitwan. Paddy yield (spring) in Morang is significantly affected by climate variables. Crops demand water, and it is expected that rainfall has a positive influence on the crop yield. Regression coefficients also show significant negative influences of rainfall on crop yield (e.g. potato yield in Banke). The effect of rainfall on crop yield depends on water requirements of the crop. Farmers irrigate the field in winter and spring as per the requirements of the crops in critical growing stages. If there is rainfall immediately after irrigation, there would be excess water and the water logging conditions that exist in the fields can negatively affect crop yield.

There is high variability in the regression coefficients of maximum and minimum temperature; the day versus night temperature affects crops differently. In many cases, maximum temperature increase has a negative influence on crop yield. However, minimum temperature increase has a positive influence. For example, the maximum temperature increment can significantly negatively affect and the minimum temperature increment can significantly positively affect the summer season paddy yield in Banke. The minimum temperature rise benefits paddy yield whereas the maximum temperature rise harms it. The standard deviations of climate variables within a growing season also play major roles in predicting crop yield. The direction and magnitude of the effects of standard deviations of climate variables on crop yield also vary. In many cases, increased standard deviations of climate variables within a growing season have a negative influence on yield, but, in some cases, they leave a positive influence. In Banke, increased standard deviation of monthly rainfall within the growing season significantly negatively affects maize (summer) yield, but significantly positively affects wheat yield.

3.2 Crop Yield Responses to Climate Variability under Different Climate Change Scenarios

The climate is changing day-by-day. The predictions of crop yield in changing climates are important for developing the agricultural sector. It is difficult to predict accurately the future climatic patterns. Therefore, assumptions are based on the historical climatic records. The past climatic trends show high annual, seasonal, and intra-seasonal variations of rainfall and temperature in the study districts. Temperature has been slightly increasing over the years whereas rainfall greatly varies (might be increased or decreased). Five hypothetical climate change scenarios have been considered to assess the possible impacts of climate change on crop yield. The first scenario represents a 2°C increment in average growing seasonal maximum and minimum temperatures. The second scenario represents 20% reduction in total growing seasonal rainfall. The third scenario represents 20% increment in total growing seasonal rainfall. The fourth scenario represents 2°C increment in average growing seasonal maximum and minimum temperatures, along with a 20% reduction in total growing seasonal rainfall. The fifth scenario
represents 20% increment in the standard deviations of rainfall and temperature within the growing season.

The impacts of the hypothetical climate change scenarios on crop yield were on the base scenarios. The base scenarios represent the existing trends that are the averages of the observed crop yield, the growing seasonal total rainfall, and average maximum and minimum temperatures from 1975 to 2011 (Banke: 1976-2011; Chitwan: 1980-2011; Morang: 1975-2010). The average yield impact of the climate change scenarios was computed by using regression coefficients for each crop across growing seasons and districts. The regression model is used for each crop at each site to compute the change in crop yield due to changes in the seasonal climate variables in five climate change scenarios. The crop yield change in the climate change scenario was expressed as a percentage change relative to the average of the observed historical yield.

The crop yield changes due to changes in climate variables in different climate change scenarios differ across the crop types, growing seasons, and locations (Table 5). The inter-district variations in changes in crop yield are due to the significant variations in district averages of rainfall and temperature. For example, the temperature increment would negatively affect paddy and maize yields in Banke - where 2°C increase in temperature leads to 38.4% reduction in paddy yield and 33.4% reduction in maize yield in summer. However, summer paddy yield would be increased by 3.2% and 1.0% respectively in Chitwan and Morang. The maize yield in summer in Chitwan would be increased by 24.2% with a 2°C increase in temperature. There is inter-district variability in the average total summer seasonal rainfall as lower in Banke and comparatively higher in Chitwan and Morang. Increment in temperature brings drought in Banke, because there is less rainfall, and drought negatively affects crop yield.

Table 5: Percentage change in crop yield due to changes in seasonal climate variables in different climate change scenarios

<table>
<thead>
<tr>
<th>Crop</th>
<th>District</th>
<th>Percentage change in crop yield in the hypothetical climate change scenarios</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Scenario 1</td>
</tr>
<tr>
<td>Paddy (summer)</td>
<td>Banke</td>
<td>-38.41</td>
</tr>
<tr>
<td></td>
<td>Chitwan</td>
<td>+3.20</td>
</tr>
<tr>
<td></td>
<td>Morang</td>
<td>+1.02</td>
</tr>
<tr>
<td>Paddy (spring)</td>
<td>Banke</td>
<td>-0.96</td>
</tr>
<tr>
<td></td>
<td>Chitwan</td>
<td>-2.19</td>
</tr>
<tr>
<td></td>
<td>Morang</td>
<td>+3.62</td>
</tr>
<tr>
<td>Maize (summer)</td>
<td>Banke</td>
<td>-33.45</td>
</tr>
<tr>
<td></td>
<td>Chitwan</td>
<td>+24.21</td>
</tr>
<tr>
<td></td>
<td>Morang</td>
<td>+4.75</td>
</tr>
<tr>
<td>Maize (spring)</td>
<td>Banke</td>
<td>-13.93</td>
</tr>
<tr>
<td></td>
<td>Chitwan</td>
<td>+7.28</td>
</tr>
<tr>
<td></td>
<td>Morang</td>
<td>+4.87</td>
</tr>
<tr>
<td>Wheat (winter)</td>
<td>Banke</td>
<td>+6.00</td>
</tr>
<tr>
<td></td>
<td>Chitwan</td>
<td>-8.59</td>
</tr>
<tr>
<td></td>
<td>Morang</td>
<td>-0.76</td>
</tr>
<tr>
<td>Potato (winter)</td>
<td>Banke</td>
<td>+4.27</td>
</tr>
<tr>
<td></td>
<td>Chitwan</td>
<td>-2.57</td>
</tr>
<tr>
<td></td>
<td>Morang</td>
<td>+4.22</td>
</tr>
</tbody>
</table>

Note: Scenario 1: 2°C increment in average growing seasonal maximum and minimum temperature; Scenario 2: 20% reduction in total growing seasonal rainfall; Scenario 3: 20% increment in total growing seasonal rainfall; Scenario 4: 2°C increment in average growing seasonal maximum rainfall; Scenario 5: 2°C increment in average growing seasonal minimum rainfall.
and minimum temperature, along with 20% reduction in total growing seasonal rainfall; Scenario 5: 20% increment in the standard deviations of rainfall and temperature within the growing season.

4. Conclusions

Regression model, based on temporal and/or spatial variations in crop yield and climate patterns, is efficient to estimate the effects of climate change on crop yield. The spatial variations of climate patterns play a significant role in predicting the effects of climate variables on crop yield. The time series regression model is good for capturing site-to-site similarities/dissimilarities in crop yield responses to climate variables. Climate change patterns and their impacts on crop yield are spatially diverse across the regions (Tao et al., 2006; Ogallo et al., 2000). Changes in climate variables influence crop yield; however, the effects and their magnitudes differ across crop types, growing seasons, and locations. Climate change can have both negative and positive impacts on crop yield that depend on the characteristics of crops and physical growing locations (Kim and Pang, 2009). High intra-regional variations in the averages of rainfall and temperature are the major reasons for dissimilar impacts of climate change on crop yield in different locations of a region.

The study concludes that climate variables and their deviations within the growing seasons are the primary determinants of crop yield in rain-fed agriculture. The crop yield-climate relationship heavily depends on crop types, growing seasons, and spatial trends of climate variables. Intra-regional variations in climate patterns also influence crop yield differently in different locations within the same climatic region. It is, therefore, difficult to generalize the effects of climate change on crop yield. Agriculture adaptation strategies for minimizing the risk of climate change have to be identified and prioritized on the basis of crop types, growing seasons, and locations.

The empirical analysis does not capture the details of crop physiology, but it does capture the net effect of the processes by which climate variable affect yield. Besides climate variables (rainfall and temperature), other factors such as crop management practices (crop varieties, cultural practices etc.) also play a significant role in determining crop yield. The estimates of rainfall and temperature in this study do, therefore, not represent the correct determinants of crop yield. The findings are useful for estimating climate change impacts on crop yield and determining the most vulnerable crops for prioritizing adaptation strategies for climate change.

Acknowledgements

We are thankful to the government offices of Nepal, the Department of Hydrology and Meteorology (DHM) for providing the observed climate data and the Ministry of Agricultural Development (MoAD) for providing time series data on crop yield and the German Academic Exchange Service (DAAD), Germany for financially supporting this research.
References


Inequity in Water Distribution due to Social Heterogeneity and Its Impacts on Benefit Sharing: A Case of Farmer Managed Irrigation System from Nepal

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Abstract

Farmer managed irrigation system (FMIS) plays a crucial role in Nepalese agriculture and is regarded as more efficient and sustainable than other systems and problem in FMIS arises when the society is heterogeneous resulting in inequity in water allocation and cost distribution that can lead to the market failure. To test the idea, three irrigation systems of LoManthang, Chhoser and Chhuksang VDCs were selected in Upper Mustang, a water scarce zone of Nepal where water is managed through local institutions. The society here can be broadly divided into upper class and peasant class based upon the caste system where classes play different roles in the management of water. Altogether 151 households were selected 46 households from the upper class and 105 from the peasant class. The upper class dominates in the right over water using the water first, planting high value crops and then releasing the excess water for use by the lower class. Limited supply of water compels the lower class to plant low water requiring crops and part of their field remains fallow though it is the major labor contributor in irrigation management. Per unit water cost is higher for them. The gross margin per hectare for the upper class is significantly higher than for the peasants which are a consequence of the unequal distribution of water resources. The Lorenz Curve analysis shows that the top 20 percent of households who have access to 60 percent of water, get 60 percent of the total revenue derived from the use of water and the remaining households have access to only 40 percent of water. Gross inequity in water distribution means a large proportion of fallow and abundant land among the peasant class. The study recommends government intervention to improve the situation.

Keywords: Social-Heterogeneity, Farmer Managed Irrigation System (FMIS), Gross Margin, Lorenz Curve

1. Introduction

Nepal is an agricultural country. Agriculture contributes 39 percent to the gross domestic product (GDP) of the nation and provides employment for 66 percent of the economically active...
population (DoA, 2011). The irrigation sector can play a crucial role in the development of agricultural performance and the agrarian-based Nepalese economy. Realising the fact, the government of Nepal is giving higher priority to the irrigation sector from 1950 (Bhandari and Pokharel, 1999). The Agricultural Perspective Plan (APP) has identified irrigation as the primary input for increasing agricultural productivity (APP, 1995).

There are two modes of institutional arrangements for irrigation management in Nepal, namely farmer-managed irrigation systems (FMIS) and agency-managed irrigation systems (AMIS) (Ostrom, 1994; Pradhan, 2000; Shivakoti, 2007). The FMIS is an informal and self-organized system (Ostrom, 1994). Shivakoti (2007) has defined FMIS as simple irrigation structures but they are designed and developed on the basis of ideas related to hydrology, ecosystem and socio-economic bases, as also indigenous knowledge, skills and experiences, transmitted through generations. The AMIS in Nepal is a capital-intensive and a formal institution, organized under government initiative which gives more emphasis to physical capital than institutional capabilities (Ostrom, 1994).

However, some of the FMISs also perform poorly (Ostrom, 2010) due to caste, hierarchy, income and socio-economic heterogeneity. This results in unequal access to water (Regmi, 2007). Some studies on community managed irrigation systems of South India also show poor performance of systems especially in heterogeneous social structures (Mehta, 1997; Mosse, 1997; Bardhan, 2000). Cleaver (1998) has also noticed poor performance of community-managed irrigation systems in Zimbabwe.

The major objective of this study is to analyse the existing water distribution, cost-sharing, and benefit distribution in the study area focusing on social heterogeneity, resource distribution patterns, and how distribution of resources brings inequality in benefit distribution illustrating the case of upper Mustang to support the underlying research hypothesis.

2. Significance of the Study

Farmer managed irrigation systems (FMIS) serve 70 percent of the total irrigated land in Nepal where the performance of FMIS is better than AMIS (Ostrom and Gardner, 1993). FMIS are popular in the mountainous as well as mid-hills and plain areas. According to Regmi (2007), not every FMIS is successful and the fundamental limitation of FMIS is the heavy influence of powerful people in a heterogeneous society if the society is composed heterogeneously. In plain areas, the Jamindars (landlords) are exercise power over the peasants whereas in the mid-hills and mountainous areas, the influence of village headman (Mukhiya) and local elites is noticeable. Most of the previous studies in Nepal related to FMIS are concentrated on the efficiency issues of FMIS (Lam, 1998; Shukla et al., 1993; Shivakoti, 2007) and have ignored the local power relations operating in the irrigation system. Therefore, this study has tried to quantify the power of various classes involved in water resource management offering a feasible solution for the asymmetrical power condition.
This study contributes to methodological advancement in analysis of the political economy of natural resources such as water resource, forest resource, and other common pool resources in Nepal. The heterogeneity of power is evident in community forestry where the elite derive more benefit from the forest resource than do the poor. In pasture economy, the rich herdsman own a larger number of sheep and derive more benefits. This exercise is confined to a micro-environment, but the methodology adopted here could be used to solve a macro-level political problem, as in the case of India and Nepal over water allocation (Mollinga, 2001). The findings may help the government to formulate irrigation policies.

3. The Political-Economy of Inequality in Water Distribution: Conceptual Framework

The political economy of water resource systems of the trans-Himalayan region can be divided into political and economic components where the two components have interrelationships with physical components (Figure 1) as suggested by Zusman (1976) and Rausser and Zusman (1991). The economy consists of benefits derived in the society from allocation of water resources. The political structure is composed of policymakers, interest groups, and policy instruments. In our case, the top decision making authority, in the irrigation committee, can be considered as policymakers from the upper class. They decide how much water is to be allocated, and how much resource that beneficiaries have to contribute for the proper functioning of the irrigation system. The upper class, middle class, and lower class farmers are the interest groups. Their objective is to maximize their benefit using the scarce water resource. However, these interest groups have conflicting interests and power differential. The upper class is the richer section of the society and has more influence over decisions who get more water as owners of water resources.

The upper class has an environment where it can avail more water with less resource contribution. The middle and lower class (peasant class) get water only if they contribute labor to the upper class. The peasant class interest lies in getting more water in exchange.

Policy instruments constitute one of the major components of the political economy. Decision-makers shape policy instruments to determine how resources will be allocated in a given political system, in favor of influential interest groups (Rausser and Zusman, 1991). If the institution is more fair, decision making is more neutral.. In our case, the irrigation rules made by the irrigation committee are the policy instruments. The hypothesis is that the policy instruments made by the irrigation committee are more in favor of the upper class due to the political power held by them who influence the decision-makers and reward them (Rausser and Zusman, 1991). Sometimes, the powerful class may even overthrow the decision-makers and replace them with a new set if the decision-makers go against their interests.

The peasant class is an unorganized interest group and has comparatively less bargaining power. However, it may form a group by uniting and can influence the decision-making center to make decisions in their favor as mentioned by Zusman (1976). Under the prevalent system, the upper
class gets more water ($W_{Q1}$) with less cost incurred ($C_1$) fetching more benefit ($B_1$) for it compared to the peasant class (Figure 1).

\[ W_{Q1} > W_{Q2} > \ldots > W_{Qn} \]
\[ C_1 < C_2 < \ldots < C_n \]
\[ GM_1 > GM_2 > \ldots > GM_n \]

Where,
- $W_Q =$ Water quantity
- $C =$ Cost of water management
- $Gm =$ Gross margin (benefit)

1,2,..................n, farmers belonging to the plot 1,2,...........and n respectively.

Figure:1 Political economy of inequality in water distribution

The problem of food insecurity and out-migration of the peasant class reflects the political crisis of the water institution. This study looks for a better solution for the problem on the grounds of the bargaining game suggested by Harsanyi (1962 and 1963); Zusman (1976); Rausser and Zusman (1991), and Nuppenau and Amjath Babu (2009).
4. Application of Gini Coefficient and Lorenz Curve to measure inequality: A literature review

The Gini and Lorenz concepts have been used here to investigate inequality in water distribution and see how it brings inequality in benefit distribution. It is a popular and frequently used method to measure inequality in resource distribution such as inequality in income and land distribution (Cullis and Koppen, 2007). However, its use in water distribution is not customary. Since, water is one of the scarcest resources in nature, its distribution, obviously, is as skewed as that of the income, irrespective of geographic location. This discrepancy in water distribution and use is evident in economically rich and poor families, the higher and lower castes, those living in the undulating topography and plain areas; and those living nearby the water source and farther away from the source which often becomes a seed of conflict.

Cullis and Koppen (2007) have used the Gini coefficient to measure water use inequality between registered and non-registered water users. Another use in the water sector was done by Lawrence et al. (2002) to measure how unequal income accounts for access to clean drinking water. The review reveals that the use of Gini coefficient is still novel. The classical definition of Gini coefficient (given by Gini, 1912 quoted in Litchfield, 1999) is the relative mean difference of a unit of population. It can be mathematically expressed as:

\[ Gini = \frac{\sum_{i=1}^{n} \sum_{j=1}^{n} |y_i - y_j|}{2n^2 y} \]

Where, \( y \) is an observed value (like income, land holding, and so on) and \( n \) represents the number of units in the population (such as households, families, individuals etc). \( y \) bar is the mean value. The value of Gini exists between 0 and 1 with zero representing perfect equality and 1 perfect inequality. The higher the value, the higher the inequality.

Lorenz Curve

The Lorenz curve is the graphical representation of the cumulative percentage of value. The cumulative percentage of the individual (households) is plotted on the x-axis and cumulative percentage of income (or other value) is plotted on the y-axis. The graph developed is called the Lorenz curve which shows the cumulative income share on the vertical axis against the distribution of population on the horizontal axis (Lorenz, 1905).

5. Methodology

5.1 Sampling

Three VDCs, namely LoManthang, Chhoser, and Chhuksang were selected. The households in each VDC who use irrigation from the major canal were listed out and divided into the upper class and peasant class. Due to complex caste systems and social stratification, households involved in irrigation management committee were considered as the upper class and those not
directly involved were regarded as the peasant class. The unique features of membership in the irrigation system are higher caste, higher landholding, and higher social status. Due to the small population size of the upper class, all the households of the upper class were selected as the sample, 46 in total. For the peasant class, a sample was drawn randomly from their households list, representing 35 percent of the total population, altogether, 105 drawn from a population of 302. The sample size for this study is thus 151 out of a total population of 348 which is 43 percent which is used to draw inferences about the whole population in the study area.

5.2 Data Collection

This study is based on primary data collected from household survey and field experimentation done in 2008/09 in the selected VDCs. A semi-structured questionnaire was developed with the coordination of course supervisors before departure for the field study. The questionnaire was translated into Nepali language and pre-tested with a non-target community in ten households of Ghiling village of upper Mustang. This village has many similarities with the research area but is a separate VDC. After pre-testing the questionnaires, the necessary modifications and adjustments were made. A household survey was conducted in households selected from the three VDCs. To measure the total water quantity used by the users for their crops, the flow rate of water at different periods, areas irrigated, time of irrigation and frequencies of irrigation for a particular crop were measured in each village by the researcher himself and trained ACAP staff.

6. Results and Discussions

This section describes the quantity of water distributed, land distribution pattern, water cost, and benefit derived per hectare by each class. The quantity of water distributed and benefit derived are plotted on the Lorenz curve to describe how inequality in water distribution brings inequality in benefit distribution.

The total quantity of water used for each crop by a farmer was calculated. Table 1 shows the average water quantity used by farmers per hectare. The result shows that the upper class uses a significantly higher amount of water per hectare (5.80 thousand m³/ha) while the peasant class uses only 4.13 m³/ha. Such an unequal distribution is caused by the heterogeneity in society where the upper class believes they alone have the water right, not only in water, but also in irrigation which impacts significantly on crop production.
Table 1: Resource and cost distribution between the two classes in the study area

<table>
<thead>
<tr>
<th>Variable</th>
<th>Upper class (n=46)</th>
<th>Peasant class (n=105)</th>
<th>P value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water (000m³)/ha</td>
<td>5.80</td>
<td>4.13</td>
<td>0.000</td>
</tr>
<tr>
<td>Average landholding (ha)</td>
<td>1.60</td>
<td>0.77</td>
<td>0.000</td>
</tr>
<tr>
<td>Average fallow land (ha)</td>
<td>0.05</td>
<td>0.26</td>
<td>0.000</td>
</tr>
<tr>
<td>Water cost in Rs/m³</td>
<td>1.70</td>
<td>7.10</td>
<td>0.000</td>
</tr>
</tbody>
</table>

Source: Field Survey Results (2008/9)

The average land holding of the upper class is also significantly larger than that of the peasants who must keep a significantly larger area of land fallow compared to the upper class because of their poor access to irrigation water. It was found that the peasant class could get their turn in irrigation only after the upper class had their turn. The volume of water in the canal and duration of irrigation determines how the area is to be allocated and for which crops. Since in this semi-arid zone, agriculture production depends solely on the availability of surface water, access to water during the sowing season is of crucial significance. A significant discrepancy could be observed in irrigation costs for the upper and peasant class. Basically, three types of major water-related costs are incurred such calculation. The first one is the number of man-days involved for holding irrigation-related meetings and monitoring of irrigation activities. The second consists of cereals (naked-barley or wheat) and cash for agriculture-related festivals. The third category includes the cereals contributed for the irrigation committee and cash contribution for irrigation infrastructure. The costs for the upper class come to 1.70 Rs/m³ (Table 1).

Water costs for the peasant class include the total labor contribution for the repair and maintenance of the canal plus labor contribution for emergency periods. Like the upper class, they spend small amounts of cash and food on agriculture-related festivals, apart from that, they also pay a regular irrigation charge in turns of (cereals) to the irrigation committee and on the irrigation infrastructure in addition to free labour in the fields of the upper class and partly at a low wage rate. The opportunity cost of free labor and the amount of wage which they thus sacrifice is part of the irrigation cost for them as they are obliged to offer such services just to get water for irrigating their land. Calculating all these costs for the peasant class comes up to 7.10 Rs/m³ which is more than four times that of the upper class (Table 1).

The total revenue of each class was calculated by multiplying the farm gate price and the yield. After calculating the total cost for each group, the gross margin of each group was calculated by deducting the total cost from total revenue and gross margin per household and gross margin per ha is NRs 159.21 and NRs 85.33 thousand respectively for the upper class. In the case of the
peasant class, the total gross margin is NRs 2.9 million (which is less than half of the upper class gross margin (Table 2), the gross margin per household and gross margin per hectare of peasant class are NRs 28.18 and NRs 41.76 thousand respectively. The gross margin per household of the peasant class is thus less than 1/5th of the upper class, a consequence of the scant water allocated to them and the high water cost incurred.

Table 2: Estimation of the gross margin of upper and peasant class

<table>
<thead>
<tr>
<th>Source of benefit</th>
<th>Benefit NRs(000) Upper</th>
<th>Benefit NRs(000) Peasant</th>
<th>Variable input</th>
<th>Total gross margin</th>
<th>Cost NRs(000) Upper</th>
<th>Cost NRs(000) Peasant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Revenue</td>
<td>8,629.83</td>
<td>5,689.90</td>
<td>Total cost</td>
<td>7,323.84</td>
<td>2,959.68</td>
<td>2191.87</td>
</tr>
<tr>
<td>Gross margin/HH</td>
<td>159.219</td>
<td>28.18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gross margin/ha</td>
<td>85.33</td>
<td>41.76</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Field Survey Results (2008/9)

Calculation of Gini Coefficient

Lorenz curves were drawn for the distribution of water and revenue, using water distribution and revenue estimated previously. The water used by individual farmers for the crops during the whole cropping cycle was summed, which is regarded here as water use data for the calculation of Gini coefficient (Figure 2). The revenue data was obtained by multiplying the yield of different crops by its respective price. The revenue obtained from the various crops grown by the farmers was summed to give the total revenue obtained by a particular farmer. After getting the total water use and total revenue of a farmer, the Lorenz curves were drawn separately for water use and total revenue.

Figure 2 shows the Lorenz curve for water use and revenue distribution among the households. The graph shows a high discrepancy of water use and revenue as these curves significantly deviate from the line of equality. Both of the lines resemble the same slope. Nevertheless, the water-use curve shows slightly more deviation from the line of equality than the one for revenue, suggesting large inequality in water-use than for the revenue. It can also be inferred that inequality in revenue distribution is caused by inequality in water use. In other words, availability of a higher volume of water to produce the crops results in higher yield, which eventually brings more revenue.
Figure 2. Lorenz curve showing water and revenue distribution for households
Source: Field Survey Results (2008/9)

Figure 2 also shows that the lowest 20 percent of households have access to just 5 percent of the total water volume and the same level of revenue. In case of equal distribution of water and revenue, 20 percent of households would have access to 20 percent of water and revenue. As the things exist now, 40 percent, 60 percent, and 80 percent of households account for approximately 10 percent, 20 percent, and 40 percent of water and nearly the same proportion of revenue respectively. Only the top 20 percent of households have access to 60 percent of water, and they get 60 percent of the total revenue from the use of water.

Based upon the Lorenz curve, the Gini coefficient was calculated which was 0.49 for water use showing inequality in water distribution. The Gini coefficient for revenue distribution is 0.46 which is slightly smaller than the figure for the water. The use of Gini index for analysis of water distribution is rather new in Nepal context and there is a dearth of literature’s in this area. Yet, if the Gini index of revenue is compared with the national Gini index of income distribution (0.41), it stands higher (NHDR, 2009) suggesting that inequality in revenue distribution is higher in the study area compared to the national figure on Gini index.
7. Conclusion

A distinct social stratification is evident in the trans-Himalayan irrigation system of Nepal and the gaps observed in the quantity of water use and water costs for the two stratified classes are significantly different. The analysis of Lorenz curve and interpretation of Gini index shows that there is inequality in water distribution, which results in inequality in farm revenue. The people of the lowest stratum are substantially deprived of an equitable water share and, as a result, a significant proportion of their land remains fallow. As a consequence many households from the peasant classes are migrating to the lower regions for their livelihood. Such migration of the lower class affects the farming of the upper class which depends on the former for agriculture and non-agriculture labor. This study, therefore, recommends governmental intervention to improve the situation.
References


South-South Cooperation: The Case of Farmers' Water User Associations for Rural Reform in China

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Abstract

One major component of China's rural reform strategies has been in the field of irrigation management. This strategy, pronounced in terms of institutionally rebuilding farmer's irrigation water association for more equitable, efficient, and peaceful water use, was a model of South-South learning and cooperation. The strategy was adapted to the Chinese context and needs. This strategy not only helped to democratize farmers' participation in irrigation management but also based farmers' water user associations on hydrologic boundary. For the first time in 1995, this strategy was implemented as a pilot exercise in the 3rd Main Canal Service Area of Jingmen city of China's Hubei Province. The implementation was carried out by a team of Nepali professionals under the World Bank - funded Yangtze River Water Resources Development Project. The Nepali professional team worked in partnership with the local leading group consisting of all relevant government organizations. By 2009, some 50,000 farmers' water user associations (WUAS) were formed and are in operation in about one-third of the irrigated area of China. The Project completion assessment has shown farmers' satisfaction with the institutional reform in the local irrigation management and reported benefits in terms of ownership, reduction in water-related conflicts, reliable and equitable irrigation deliveries, increased agricultural productivity, and more effective use of local government resources. Presence of such an institutional base in the form of WUA has enabled farmers to cooperatively manage emerging challenges and concerns related to irrigated agriculture.

1. Introduction

Agriculture is the most basic sector of China`s National economy. Of the Gross Domestic Product (GDP) of USD 4,985,461 million, agriculture accounted for around 10 percent\(^2\). Twenty years ago, it accounted for 25 percent. Of the economically active population (EAP) of about 804 million, agriculture sector employed 499 million (62\%) people.

China's per capita freshwater availability is 2,111 \(m^3\) whereas the global average is 6,466 \(m^3\) per capita. Agriculture is the main water withdrawal sector, but only 45 percent is actually consumed by crops, due to low efficiency in irrigation systems. This figure is comparatively high


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considering the cropping structure. The relatively poor water productivity in the country, USD 3.6 per m³, is lower than the average of USD 4.8 per m³ in middle income countries.

Of the total area with irrigation in China of 62.6 million ha, 57.1 million ha (91.2%) were under food crops. A 2006 assessment report indicated that all the reported irrigated areas did not receive irrigation water service evenly. The figure on drought stricken farmland every year has reached an average 15.3 million ha, nearly 13 percent of the total farming area.

Irrigation makes a major contribution to food security, helping an irrigated cropping intensity of 1.72. The major irrigated crop is rice, followed by wheat and maize. The average paddy rice yield of irrigated farmland was 7.3 tons/ha (about three times more than the non-irrigated one). In 2005, almost three-quarters of grain production came from irrigation. The importance of irrigated vegetables is also growing.

The United Nations predicts that China’s population will increase from 1.2 billion to 1.5 billion between 2020 and 2030. To feed the increasing population, China has to increase the total agricultural products by almost 30 percent by 2030. The quantitative expansion of irrigation will be difficult as rapidly urbanizing population is expected to further push water demand to new heights. The expanding industrial sector is also greedy for water.

Operating the landholding scale of farmland and its expansion, institutionalizing the operation of market economic principles and implementing irrigation management strategy to promote rural reform agenda with a focus on equity, efficiency, and social stability in the use of irrigation resources pose both challenge and opportunity. As far back as 1992, the government announced the goal of establishing a socialist market economy. Before the market economy, China had adopted a centrally planned economic system. In this system, the state determined production and pricing. In a market economy, however, consumer demand for goods and services determines production and pricing. The new market economy system with Chinese characteristics asks for rules and institutions that create level playing field for the stakeholders.

As a matter of fact, the first reforms toward achieving the new national objective of modernization and richness had begun in poor rural areas in 1979, when the government replaced communal farming and distribution with the household contracting and responsibility system. Under this system, individual farm households worked separate plots of land owned by an economic collective. The households could sell produce at farmers’ markets for whatever price buyers were willing to pay in return for selling a certain amount of produce to the collective at a predetermined price. The contract and responsibility system was successful because it gave farmers an incentive to reduce production costs and increase productivity.

Under these circumstances, the Chinese practice would be to make the progress step by step and make major breakthrough for a institutional reform with a series of experiments. This would be achieved first by solving the easy ones, then the difficult problems, proceeding in an orderly way while losing no time to make the breakthroughs to push institutional reform to achieve self-management units at each level. Macro-economically, market guided reform measures of the
economic system would be planned to meet market economic system requirements. At the same time, it would also open the ground for the south-south and south-north learning and cooperation for changing the nation's socio-economy. In other words, micro-economically, the reform would change the institutional mechanism of irrigation system internally meeting the needs of development of the socialist market economy.

2. Irrigation Management Challenges and Scenario

Foregoing introduction suggests that irrigation management in China needs to address and resolve the following challenges:

- Make the agricultural sector, where a larger majority of EAP were engaged, socially and economically more beneficial;
- Enhance more productive use of irrigation water, which was getting scarce and thereby saving it more;
- Ensure food security;
- Assure weather uncertainty triggered by climate change;
- Ensure orderly transition of farming community from a centrally planned economy to socialist market economy;
- Link rural development and reform to a national modernization framework.

Irrigation sector scenario

The situations prevailing in the irrigation sector were simply not able to address and resolve the challenges listed. The challenges were not only a reflection of China's centrally administered planning but also opening up to international community (like WTO). They also indicated China's standard approach in dealing with irrigation as only a technological one.

The existing irrigation and drainage management structure was based on administrative boundaries (i.e. village boundaries). The Village Committee (VC), the grassroots level organization, supported the higher local government unit (township, county, prefecture or municipality) which had the authority for the construction and maintenance of irrigation, drainage canal, and the pump stations. A public utility or local government's water resources bureau at the township, county, prefecture or municipal level had the authority to collect water charge and operate the irrigation, drainage system including the pump stations. The VC was responsible for irrigation and drainage operation. In such a system, irrigation system management was dispersed among different levels of government administration, rather than consolidated in a more efficient hydrologic unit.

Irrigation water was priced below cost, or not charged at all. As a result, each irrigation system had started to become a historical burden on government administration, which lacked funds for
the operation and maintenance (O&M). “Gray water charges” were rampant in the sense that the charges were collected in the name of water but used for other purposes (such as for partying and administrative expenses). Moreover, the water charges that farmers actually did pay were calculated in terms of the land area irrigated rather than by the volume of water used. Farmers thus had no incentive to use water efficiently.

The authorities and accountabilities of farmers and public water utility were not clear. Farmers viewed the O&M of this utility as very expensive. As farmers did not recognize their responsibility within the public water utility, there was no effective mechanism to ensure an accountability system for efficient water use. Thus O&M was generally inadequate since the maintenance resources allocated by the central and provincial government did frequently not match with the O&M needs. Further, the central government efforts at decentralization and reducing central investment resources had diminished the ability of the Ministry of Water Resources (MWR) to systematically guide and influence a comprehensive water resource development policy.

Distribution of irrigation water between the head and tail ends of the system was also inequitable. In such a situation, the farmers often conspired against one another to get better access to water preventing them from mutual intervention and interaction for better form of irrigation and drainage management and decisions-making.

Institutionally, such an organization framework did not provide opportunities and incentives to the farmers for their direct participation. Most of the medium and large irrigation scheme's management was fragmented and dispersed. As a consequence, farmers' participation in system operation and decision-making process were limited, resulting in low system efficiencies averaging 30%-40%, massive waste of water, and low productivity of water used.

Environmentally, a large part of the cultivatable land deteriorated through water logging and soil salinization due to ineffective drainage control for the rising water tables. Further, uncontrolled construction of tube wells prompted by government subsidies had led to over-exploitation of groundwater, falling water tables, and land subsidence.

Investment and maintenance on-farm facilities (formerly a communal responsibility during the slack winter season) were replaced by the household responsibility system in reference to a self-managed cooperative accountability. The change led to a situation of self-seeking practice as the households tended to look after their own individual contractual interests.

No systematic institutional and legal framework was in place to handle competing water demands. A water requirement for the growing demand of municipalities and industrial areas was not met adequately and these areas were eyeing farmers' institutionally weak irrigated agricultural sector, the main water consumer.

The severity of constraints and problems of irrigation increases as the population grows and the economy becomes more market-oriented. A Chinese Five Year Plan took note of the severity.
The importance of comprehensive water resources management was well recognized and put as a priority issue at the policy level.

The World Bank appraisal and assessment of irrigation component of Yangtze Basin Water Resources Project found that China was always effortful to address and resolve the irrigation management issues at the local level. Accordingly, it adopted financial, administrative, and technical measures for the project. But the extent and nature of the issues did not only ask for more cost-effective and accountable use of the scarce government resources, but also for farmers' direct participation and resource utilization in a way that was comparatively advantageous to promote the adaptability, effectiveness, and efficiency of the irrigation system.

The Bank's appraisal and assessment of China's irrigation administration derived inspiration and lessons from i) the farmers' self-managed irrigation development program that the Bank had executed in Nepal (1989-1993); ii) Mexico government's irrigation management transfer program implemented in 1989-1994; and iii) China's own historical indigenous irrigation management practices. In each of these appraisals and assessments, benefits were recorded in terms of i) farmers' inclusive participation through formation/strengthening of their own water user association (WUA); ii) accountability and cost-effectiveness of WUA in irrigation management tasks (water allocation, distribution, irrigation operation and maintenance, irrigation fee determination and collection, organizational development); iii) reduced irrigation cost for both farmers and local government; iv) reduced water related-conflict at the local level due to equity in water distribution and resource mobilization; and v) diversification and adaptability in resource mobilization, use, and maximization. The most basic and critical element in these successful programs and practices was farmers' own organization that owned and took responsibility for efficient and effective irrigation within the jurisdiction of their organization.

3. Irrigation Management Reform Strategy

Taking into consideration the successful international initiatives and China's own good indigenous irrigation practices, a new irrigation management reform strategy called self-financing irrigation and drainage development (SIDD) program was planned to serve China's needs. SIDD was defined as "an establishment of sustainable resource-based system that enables farmers to institutionally assume greater responsibilities for and control of operation, maintenance, and management of irrigation infrastructure and services at the local level." It was made a component of the World Bank-prepared and -funded Yangtze River Water Resource Project in China’s Hubei and Hunan provinces.

As an irrigation management system, SIDD was structured in two integrated parts: WUA operating as the farmers' own water use organizations, taking care of the lower distribution

network on the ground. The second was a water supplier (WS—a public utility, authority or corporation) water supplying to the WUA from an outlet in the canal system. Both parts would treat water as economic goods playing the role of a commodity, reflecting the buy-and-sale nature of a market. In such an integral form, however, neither WS nor WUA would be a profit-oriented entity but would function as a non-profit social productive service for farmers as end users of the irrigation water. By virtue of its nature, SIDD model would be characterized by two meaningful transfer processes: transfer of local irrigation management from government to farmers themselves, and transfer of the economic foundation of local irrigation system from a planned command economy to market economy.

In the SIDD areas, WUAs directly purchased water from the WS in terms of the cubic meters of water used. Usually, WS delivers and measures water volumetrically at the WUA head gates/outlet in the presence of the WUA representative. Water deliveries at the WUA by the WS were governed by the water sales agreement between the parties regulated by their contractual obligation. The obligation often specified the rights and responsibilities of both. Since water deliveries were charged volumetrically, WUA farmers had a strong incentive to use water more efficiently and reduce waste. WUAs collected water charges from their member farmers and bought water from the WS on behalf of their members based on water demand. WUAs, with support of the concerned water resources bureau, were registered as legal persons with the local Civil Affairs Department and WS were chartered under the National Company Law. WUAs registered as legal persons with the Civil Affairs Department of the Ministry of Civil Affairs could independently manage their affairs and contract, lease, or auction the O&M of their canals and facilities if necessary. WUAs coming within the jurisdiction of a Village Committee would be legal but not independent to conduct any financial or commercial deals with another party.

3.1 Five WUA principles

The quality of formation and functioning of WUAs very much depended on the following five principles:

i. They are farmers' own organizations, with democratically elected committees and freedom in financial management, and relative operational independence from government on routine activities.

ii. They are based on hydrological boundary as the WUA boundary.

iii. They measure water flows at intakes from the water supplier and pay water fees according to the volume of water supplied.

iv. They deal directly with the water supplier. They collect fees from members and pay directly to the water supplier.

v. They have a reliable water supply and functional distribution system.

3.2 Implementation Challenge and Strategy
Despite the soundness of the SIDD program in terms of its international success and locally adaptable scientific principles, local stakeholders (local political party and provincial government officials, farmers, and officials of central government program such as Comprehensive Agricultural Development) would not be convinced unless they saw how it actually worked on the ground. A section of local leaders also viewed the program as "interference in their sovereign rights." As such, the World Bank Technical Assistance Team (TAT) for SIDD composed of professionals coming from Nepal adopted a two-pronged strategy to implement the program: i) prepare the local counterpart team for the program and ii) design program implementation procedures. The two-pronged strategy was implemented on the basis of the following tasks:

(a) Observation study of successful international experience and practices;
(b) A pilot approach for WUA development with selection criteria for the pilot WUAs;
(c) Involvement of key stakeholders in the form of project leading group for preparation and implementation of the SIDD plan;
(d) Detailed projections of sub-projects investment, operation, and self-financing costs;
(e) Delineation of hydrologic boundary as the basis for and membership make up of the WUA organizational structure;
(f) Survey and analysis of farmer income with and without SIDD
(g) Management assessment and capability training and orientation on tasks to be undertaken (hydrologic boundary delineation and membership identification, WUA relations with WS, survey and analysis of farmers’ characteristics etc.); and
(h) Procedures for Monitoring & Evaluation (ME) of SIDD including specifications of key indicators, baseline data collection, periodic survey, progress monitoring, and impact evaluation.

4. Cases from Hubei Province

4.1 Source of water for pilot area

The head gate of the 3rd Sub-main Canal was located at 36+800 km, that is, the lower part of the 3rd Main Canal. The design discharge of the 3rd Sub-main Canal was 7.7 m³/sec, with an irrigation area of about 115,000 Mu (15 Mu=1 ha.) and length of 27.4 km. It was completed in 1965. The efficiency of the canal was declining from the very beginning. The capacity of the

[28] This team of the World Bank professionals was supplemented by Chinese experts. Notable one in the Chinese experts was Mr. Liu Hubin, senior engineer and former Standing Deputy Director, Project Management Office for Yangtze River Basin Water Resources Project. Liu richly assisted the team with his insights, knowledge and experience of irrigation in central China.
upper part (19.2 km) of the Sub-main Canal was only 6.0 m³/s and the lower part (8.2 km) was almost out of service because of siltation and damage of canal banks.

The 3rd Sub-main Canal was run by Liuji Management Section (LMS), the WS, of the 3rd Main Canal Management Division (TMCMC). Under LMS there were 5 distribution groups with 2-3 farmers employed by each group and 12 for all the groups. The annual wage of each employee was 1080 Yuan (8 Yuan=1 USD). LMS had 6 permanent staff. The annual amount of water distributed by LMS was 10,000,000 - 12,000,000 m³, total water charge was 140,000 – 150,000 Yuan from which 40,000 – 50,000 Yuan was for LMS. The annual operational cost of LMS was 80,000 - 100,000 Yuan.

The Jingji Reservoir, a medium-sized reservoir, supplied irrigation water for the 3rd Main Canal area. While the total capacity of reservoir was 17,700,000 m³, the effective capacity was 9,600,000 m³. The design irrigation area was 56000 Mu. The actual irrigated area was not more than half of the design irrigation area. The number of staff employed by the Jingji Reservoir Management Division (JRMD) was 26, among which six performed the irrigation management tasks and others were engaged in Jingmen Municipality works.

4.2 The first Hongmiao WUA in Hubei Province

The Hongmiao WUA, the first WUA established on 16 June 1995 in the Zhanghe irrigation area under the leadership of Provincial Project Management Office (PPMO), was the first pilot project for SIDD program undertaken in a learning-by-doing method. It covered the Hongmiao branch canal of Zhanghe irrigation area of the 3rd Main Canal in Jingmen Municipality. The branch canal was 4.9 km long, with two laterals of 3.2 km long. The Zhanghe irrigation system, a gravity multi-functional irrigation system (flood control, electricity generation, water supply, and irrigation) was fed by the Zhanghe reservoir. The Hongmiao branch irrigated an area of 5200 Mu, covering 525 water user households of 19 villager groups in three villages under two townships. It was constructed in 1965, with a designed capacity of 1.0 m³/s and designed irrigation area of 7950 Mu. The level above the intake canal was managed by different villages. Since there was no unified and effective water management organization, each village only considered its own needs, consequently deteriorating the irrigation system.

Hongmiao Branch Canal water user organization had two tiers. The 525 user households in the area elected 26 representatives for a WUA Representative Assembly. The WUA Representative Assembly elected 3 WUA Executive Committee members. They discussed and worked out a WUA Charter and related regulations and established a WUA accounting system. At the lower level, the irrigation area was divided into five water user groups based on hydrologic boundaries. Each one of these groups had one chief representative for the organizational tasks.

[29] The formation of the first WUA in the Hongmiao Branch was celebrated in a public program attended by all senior local leaders and a massive number of people. The local news papers acclaimed the event with the comment that the formation of first WUA, an exercise in direct rural democracy based on scientific hydrological principle, was a historic event perhaps only second to the Founding of the People's Republic of China in 1949.
In the initial stage of pilot experimentation, satisfactory achievements for further demonstration of pilot experimentation in local context were promising. Continuous support from the municipal government of Jingmen city encouraged half dozen of WS staff to get integrated with TAT in a learning-by-doing mode. The staff were exposed to the SIDD concept, principles, and procedures, and relevant international experience. The commitment of the municipal government and dedication of staff to realize the project’s SIDD objective, especially relating to WUAs, was reflected in their formulation of a draft document entitled “Legal Measures for WUA Management.” This document was the first enabling instrument in the successful establishment of the SIDD.

4.3 Yugang WUA

The accomplishment of South-South learning was right away extended to Yugang WUA in Shayang County in the 3rd Main Canal in Zhanghe Irrigation area. The WS staff demonstrated their ability to work with farmers and farmers in turn showed their ability to get organized around a WUA according to the WUA principles. Farmers were aware that they were being mobilized through WUAs for their own benefit. Such mobilization also brought about new impetus and fresh air to local village routine works. Villagers felt happy with the WUAs as an "organized hand" helping in dealing with irrigation matters and local systems maintenance, with a better opportunity for diversified income generating activities.

Farmers elected WUA’s key office bearers. They decided the canal maintenance and improvement plan, water use plan, and financial and human resources needs through their assembly of representatives of the 84 off-takes within its hydrologic jurisdiction. They invited village committee leaders in their meetings. WUA mobilized financial and labor resources from farmers equitably and on a no-profit-no-loss basis.

Yugang WUA covered 15,000 Mu of farmland and annually paid Yuan 100,000 as water charge. Water charge included a basic fee (to be paid by all water users irrespective of water supply) of 2 kg (rice)/mu and 3.5 kg/100 cm for volumetric supply of water. It added 3 to 5 percent service fee on water charge to meet its O&M costs. The institution of WUA had assured equal treatment to all member farmers in the WUA including the tail-end farmers. They solved problems of internal water conflict and dispute by establishing penalty system. Doing this relieved the village committee and township government, the lowest level local government unit, of water conflicts and disputes in the area. Formation of WUAs also increased water conveyance efficiency in the canal and assured better yields (for example, paddy yield was increased by 150 kg/mu on an average). WUA had replaced 168 water guards (two each in one off-take area) by eight staff. Thus, it had become more effective in labor use. About 25% of saved labor were engaged in industrial and construction services in the neighborhood. Major works were started with the rehabilitation of the old canal along with the World Bank’s structural improvement works after

the formation of WUA. This resulted in increased water flow efficiency from 1.5 to 2.0 cm/s in the lateral canal, which was operated and maintained by WUA.

The overall institutional development impact that WUAs made was substantial. WUA also played an effective role in developing self-management culture at the local level. It, however also gave farmers a new confidence and an alternative mechanism that helped them to decide for themselves on matters that fundamentally affected their livelihood on a day-to-day basis. In most cases, WUA and village took up issues to tackle in village life. This meant they were not competitive but actually cooperating with each other for diversified use of saved labor in construction and industry, saving water for higher value use, and increasing per unit productivity of both the water and labor used. This new irrigation management situation won support also from the local government units and village committees as WUA-managed water substantially reduced water-related conflict. This led to ensuring peaceful relations between the farmers within the WUA area contributing to social stability, the topmost concern of the local political leadership. The WUA impact was remarkable especially in view of the "suspicion" that local government units had about WUA at the beginning of the SIDD implementation.

After setting up of WUA, members did an excellent job both in the construction work and O&M of the system under the leadership of WUA. For the situation before and after WUA, two comparative tables are given below (Tables1 and 2).

**Table 1: Engineering works done by WUA (1995-1997)**

<table>
<thead>
<tr>
<th>Contents</th>
<th>Quantity</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Farmers labor input</td>
<td>More than 30,000</td>
</tr>
<tr>
<td>2. Earth work finished</td>
<td>250,000 m³</td>
</tr>
<tr>
<td>3. Canal lining finished</td>
<td>1.3 km</td>
</tr>
<tr>
<td>4. Improvement in branch canal capacity</td>
<td>from 0.5 m³ (before WUA) to 1.5 m³ (after WUA)</td>
</tr>
<tr>
<td>5. Improvement in lateral canal capacity</td>
<td>from 0.3 m³ (before WUA) to 0.8 m³ (after WUA)</td>
</tr>
<tr>
<td>6. Road on the dike/bank</td>
<td>5m wide, 4.9 km long</td>
</tr>
<tr>
<td>7. Structures</td>
<td>1119 (including gates, culverts, check gate, and bridges)</td>
</tr>
</tbody>
</table>

**Table 2: Comparative situation before and after WUA**

<table>
<thead>
<tr>
<th>Contents</th>
<th>Comparison 'Before' and 'After' WUA</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Number of labor to guard water</td>
<td>'Before' WUA: 2,040 labor/year</td>
<td>'After' WUA: 340 labor/year, Saved 60 yuan/ha</td>
</tr>
<tr>
<td></td>
<td>'After' WUA: 340 labor/year</td>
<td></td>
</tr>
<tr>
<td>2. Irrigation water saved</td>
<td>'Before' WUA: 6,450 m³/ha</td>
<td>'After' WUA: 5,000 m³/ha, Saved 22% of water</td>
</tr>
<tr>
<td></td>
<td>'After' WUA: 5,000 m³/ha</td>
<td></td>
</tr>
<tr>
<td>3. Increment in agriculture production.</td>
<td>'Before' WUA: 11,250 kg/ha (two crops of paddy and wheat). The ratio of output to input is 161 %.</td>
<td>'After' WUA: 13,095 kg/ha (two crops of paddy and wheat). The ratio of output to input is 227 %, Grain production gain by 1845 kg/ha, of which the gain part due to improvement of irrigation is 738 kg/ha.</td>
</tr>
<tr>
<td></td>
<td>'After' WUA: 13,095 kg/ha</td>
<td></td>
</tr>
<tr>
<td></td>
<td>'After' WUA: 13,095 kg/ha</td>
<td></td>
</tr>
<tr>
<td>4. Water charges and equity</td>
<td>Water charge for head end was 45-75 Yuan/ha and that for tail end was 300 Yuan/ha.</td>
<td>Water charge for the head end was 195 Yuan/ha and that for tail end was 262 Yuan/ha for the year.</td>
</tr>
<tr>
<td></td>
<td>'After' WUA: 195 Yuan/ha</td>
<td></td>
</tr>
<tr>
<td></td>
<td>'After' WUA: 195 Yuan/ha</td>
<td></td>
</tr>
<tr>
<td>5. Conflicts</td>
<td>A lot of conflicts over disputes over water, blocking canal etc.</td>
<td>Smooth irrigation order, no more conflict about using water.</td>
</tr>
</tbody>
</table>
6. Condition of irrigation facilities

| A lot of damage to irrigation facilities. Of the original 32 structures, only a few were left. | Repaired and newly constructed more than 100 structures; O&M agreements signed between WUA and WUG; Irrigation facilities in good shape. |

7. Involvement of township and village leaders

| A number of leaders had to go to the field to solve conflicts during irrigation season. | Two years after WUA, there was no need for leaders to go to the field during irrigation season |

8. Reduced middle links, foundation laid for independent operation of SIDD

| 5-6 middle links existed in the process of water charge collection. Farmer had to pay more than they needed. | Water charge directly paid to water supply organization; both farmers and water supply organization feel satisfied. |


5. Conclusion

Improvement measures were to be continuously identified and incorporated in the SIDD WUA plan to address the lessons learned and absorb new dynamism in WUA development. The SIDD must be an adaptive mechanism\textsuperscript{31} that is able to show how it effectively addresses ecological and social issues so that water resources line agencies continue to provide regular support to SIDD after the project. A permanent support system was very important because SIDD has already come out of the “piloting” stage and has entered a scaled up regular rural management reform program stage. Recently it was estimated that some 50,000 WUAs have been formed in several provinces, autonomous regions, and municipalities of China, covering about one-third of China's irrigated area\textsuperscript{32}.

Acknowledgement

The author is thankful to Dr. Krishna Paudel, Senior Water Resources Engineer and Ms Sangita Maharjan, Program Officer, Consolidated Management Services (CMS) Nepal, for the technical inputs in the analysis and formatting of the paper.

\textsuperscript{31}. Reidinger, R. 2011. Communication of Richard Reidinger to Upendra Gautam. This communication informs, “… Of late, they have been instrumental in “Mainstreaming of Climate Change Adaptation into Irrigated Agriculture Project,’ which were attached to the huge Irrigated Agricultural Intensification III Project or IAIL3 just closed at the end of 2010. WUAs have become a key part of both IAIL3 in terms of providing a primary mechanism to teach the farmers about climate change adaptation as related to irrigation actions the farmers can take to mitigate climate change impacts, etc. One of the actions taken by farmers with the WUAs under the project was to change crop varieties. …To compensate for warming temperatures, China has recently been using a little trick … that might also work in Nepal. They have been introducing varieties from northern areas into southern areas (as well as breeding for drought resistance). This type of varietals change is relatively easy and would save the plant breeders a lot of time and effort”. 27 April and 23 May.

\textsuperscript{32}. Reidinger, R. 2011. Communication of Richard Reidinger to Upendra Gautam. This communication informs, “…In 2009 there were some 50,000 WUAs in China, and they cover about a third of the irrigated area. …About 20,000 are registered and therefore have independent legal status. Only the registered WUAs can own property (i.e, their irrigation facilities), have a bank account, sign contracts, etc. Most WUAs are established under the village committee, which makes them legal, but they are not independent or able to have the above key rights”. 23 May.
Food and Nutrition Security in Nepal: A Review of the Policies and Strategies in the Forestry Sector

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Abstract

The main objective of the paper is to share a bird’s view of contribution of the forestry sector in food and nutrition security of Nepal. Review of secondary information, consultation, and interviews have been applied in the study methodology. Food security mainly includes production, access, and distribution. At the district level, there are the food security groups but the forestry sector has not been included in that group. This review shows that the major areas of forestry sector contribution in food security are: (a) livelihood improvement program of leasehold forestry program for the poor in which forest land is ensured for groups of poor households for 40 years to make use of the lands for short-term and long-term crops, (b) livelihood improvement programs including land allocation to poor households in community, and (c) harvesting and selling of non-timber forest products and/or medicinal aromatic plants (NTFPs/MAPs) production in community and leasehold forests for sale to traders. The forest products that directly or indirectly contribute in food security are:

- Directly consumed foods: fresh vegetables, fruits, oils at household level
- Marketable products: Fruits (Aiselu, Kafal), Bamboo and Nigalo shoots, Okhar
- Processed goods in market for consumption: Sisnu powder, Lapsi candy, seabuckthorn jam and juice, Bel (Marmelos) juice, Gurans (Rhododendron) juice
- Processed (value added) non-edible goods that provide income to people
- Unprocessed goods/NTFPs/MAPs exported outside Nepal that provide income
- Timber products: Firewood and timber cutters (Daure) depend on it.
- Timber and firewood harvesting, transport, and processing
- Interventions in forestry sector in the form of leasehold forestry for the poor and land allocation in CF
- Shifting cultivation in steep hills that provides food items

No exact data exist yet on contribution of the forestry sector on the theme of food security. There are some pieces and fragmented information.

The forest dependent communities in Nepal are Chepang, Bankariya, Raji, and Raute. The Raute population around 500 are nomadic forest dwellers in the mid-western hills primarily dependent on forest products for their livelihood. Chepang (Praja), who live in the hills of...
Makwanpur, Chitwan, Dhanding, and Gorkha districts of Central Development Region largely depend on forest products, particularly during the food deficit period. A symbolic relationship exists between Chepang, the Chiuri tree, bat and honey bee.

1. Introduction

This paper aims to assess the forestry sector policies, strategies, and programs contributing to food and nutrition securities in Nepal.

The observation used was: review of policies and strategies related to forestry ad food security in Nepal, major forestry sector programs in Nepal and their target groups, and programs that said to be contributing in food security.

2. Emergence of Food and Nutrition Security Policy in the Forestry Sector

Forests have been the source of food and nutrition for women, men and children since time immoral in Nepal. They remain the major source of food, nutrition and livelihood primarily for forest-dependent indigenous people. *Githa* and *Vyakur* are used by the Chepangs as food during famines and also by the poor households living in the vicinity of forests. But there are certain food items which are popular in the urban households. Nigalo shoots (*Tusa*), young bamboo shoots and its fermented products *Tama* are a delicacy in urban families. *Kafal* and *Aiselu* are popular fruits. *Tejpat*, *Jimbu* and *Timur* are spices used for delicacy. *Amla* pickle is very popular; processed Bel juice is a popular drink for good health.

During Rana regime, forests were source of revenue for national treasure, Rana family members and their dependents where forests were given as Jagir. But the Forest Nationalization Act 2013 nationalized all private forests and brought them under the Government.

Leasehold forests were principally conceptualized to involve forest product-based industries in the National Forestry Plan 1976. However, it was introduced as a priority agenda for the local community through the forest dependent Chepang when king Birendra Bikram Shah visited the Central Development Region. Leasehold Forestry Regulation 1978 was amended to include the "Leasehold Forestry for the Poor Communities" in 1989 and the Hills Leasehold Forestry and Forage Development Project conceptualized in 1989/90 was started in 1992/93. Forest Act 1993 and Forest Regulation 1995 have provided the legal basis for the implementation of leasehold forestry for poor households. Leasehold Forestry Policy 2002 further strengthened it. The Tenth Five Year Plan (2002-2007) made leasehold forestry for the poor as Priority One Program. Now Leasehold Forestry is part of poverty alleviation program of the Ministry of Forest and Soil Conservation. This has been implemented in 22 hill districts and 11 Himalayan districts of Nepal. At present, there are 7413 leasehold groups covering 74,950 poor households and holding 42,733 hectares of lease land with exclusive use rights for forty years. These leasehold groups start with Livelihood Implementation Plan (LIP) that directly promotes their food and nutrition security. In recent years, Leasehold Forestry and Livestock Program has started with a new
vision of corridor or landscape approach re-storing and re-establishing shifting cultivation areas and involving the poor households with intensive support. This has helped to alleviate poverty within a short period (less than 5 year) in Palpa, and hill zone of Nawalparasi. Such move for poverty alleviation have contributed solidly in the food and nutrition security of poor households.

Biodiversity Sector Program for Siwaliks and Terai (BISEP-ST) introduced and popularized the leasehold forestry for the poor in public lands (lands owned by VDC, DDC, trustees, schools) in 2001-2006.

The concept of community forestry was introduced with promulgation of Panchayat Forest Regulation 1978 and Panchayat Protected Forest Regulation 1978 which became "community forest" in late 1990s. However, Livelihood and Forestry Program (2001-2011) and SDC-supported Community Forestry Program (2004-2008) introduced forest-based livelihood were focused programs and intensively introduced in the project areas of 19 districts. Allocation of forest lands to the poor household users in community forests and of 35% budget for poverty alleviation are positive aspects and strategic thrusts in promoting food and nutrition security for poor households in the forestry sector. At present, there are 17,809 community forest user groups in 74 districts including 1,194,545 households that managing 1,665,420 hectares of forest area. Many community forest user groups have started livelihood improvement programs including income generating activities, skill development and land allocation for poor households that directly contributes to their food and nutrition security. Community forest areas cover more than 30% of the forest area of national forests and 22% of the total households (54,27,302) as per of National census of 2011. There are the major strategic moves toward food and nutrition security through community forestry in Nepal.

Aiming to reduce conflict between the Protected Areas (National Parks, Wildlife Reserves, Hunting Reserves, and Conservation Areas) and the local community people, the Buffer Zone Management Regulation 1996, under the National Parks and Wildlife Conservation Act 1973, opened the avenue for people's participation in park management introducing the concepts of core protection area and the buffer zones. At present, 30-50% of the revenue from the Protected Areas are spent in local community development including poverty alleviation through the Buffer Zone Council and Buffer Zone Committee. Projects/Programs have been launched in such buffer zones for skill development and income generation of poor households that have promoted food and nutrition security. For example, Raji indigenous community traditionally depend on fishing for livelihood and source of nutrition in Bardia district; after declaration of Bardia Wildlife Reserve, later Bardia National Park were prohibited to fish in rivers of buffer zone areas, but now are allowed fishing when they raised their voice for livelihoods.

**Tenth Five Year Plan and Interim Plans**

Nepal has 5.5 million hectares of forest areas, about double the area of agricultural land. The forestry sector is already contributing in food and nutrition security in Nepal, but it is not accounted for separately because these food-based food items do not add significantly to the revenue in the forestry sector which has not been given due importance specifically in terms of food and nutrition security. Yet, contribution of community forestry and leasehold forestry and Non-Timber Forest Products and/or Medicinal and Aromatic Plants (NTFPs/MAPs) is visible in food and nutrition security.

3. Policies and Strategies related to Food and Nutrition Security

Food security in MDG: Forests are directly and indirectly contributing to achieve the following millennium development goals (MDG) in addressing poverty into the country. They are: Goal 1: Eradication of poverty and Goal 7: Ensuring environmental sustainability. Most of the people living in the vicinity of forests are poor and depend heavily on forest for their livelihood. Almost 69% of the energy need comes mostly from biomass fuels, mainly firewood. Most of the rural people depend on medicinal plants and animals as their primary source of health care. ANSAB estimates NR 1.5 billion equivalent of NTFP trade in the country in 1995 (Subedi, 1997).

FAO Rome Declaration on Food Security: Food security has been defined by the Committee on World Food Security as the "economic and physical access to food, of all the people, at all times". Food security is crucially dependent on reliability of products and on people's access to supplies. It thereby encompasses questions of both sustainability and equity (FAO, 1989). Three elements of food security are: (i) availability of staple foods; (ii) stability of supply; and (iii) access for all to these supplies. The Rome Declaration has reaffirmed the right of every one to have access to safe and nutritious food, consistent with the right to adequate food and the fundamental right of everyone to be free from hunger (World Food Summit Declaration, 1996).

Forests and trees have an important role in the struggle to reduce poverty. Initiatives based on sustainable local forest management, as part of rural development and sustainable livelihood strategies, can support good governance and increase benefits to poor. The challenge now is to turn this potential into reality (FAO/DFID, 2001).

Forest plays a vital role in global food security providing food, fodder, fuel, and medicine (www.fao.org/gender/en/fore-.-htm).

The definition of food and nutrition security for the first time emerged from the first World Food Conference of 1975 and focused on "the availability at all times of adequate world supplies of basic food stuffs to sustain a steady expansion of food consumption" (Maxwell and Watkins, 2003, quoted by SCF, 2008). This definition mainly focused on the availability and ample supply of food to the needy people. This does not explain the seasonality, location, and variation among the needy people. The food and Agriculture Organization (FAO) of the United Nations has defined food security as assuring to all human beings the physical and economic access to basic foods they need. This implies three different aspects, namely availability, stability and access (FAO, 1999).
The Census of 2011 has revealed that there are 8.46 millions Janajatis which comprise 37.2 percent of the total population of the country. The DFDIN Act 2002 has enlisted 59 ethnic groups as "indigenous people" or "nationalities" among whom Chepang, Bankaria, Raji and Raute are largely dependent on forests for their livelihoods.

**FAO Country Framework, Nepal (2013-2017):** The CPF for Nepal outlines the joint Government of Nepal (GON) and FAO's medium-term priorities for FAO's technical assistance over the five-year period (2013-2017). The CPF has identified four priority areas for technical cooperation each with three outcomes and 52 outputs in total. Priority Area 1 includes "food and nutrition security and safety.

**Draft Agriculture Development Strategy (2013):** It has visualized the maintenance of 40% forest area and efficient and sustainable practice of natural resources for agriculture development.

### 4. Contribution of the Forestry Sector in Food and Nutrition Security

#### 4.1 Timber Collection and Processing

The average commercial timer sale at the national level is 1.32 million cubic feet per year. For the processing timber from forest to depot, average cost is NRs 45 per cubic feet. A million cubic feet generates 0.474 million person days employment annually which does not include employment of timber harvesting in community forests, and leasehold forests nor does it include firewood collection and sale by individuals in government-managed forest for homeuse as well as sale in local markets for livelihoods nor illegal harvesting and sale. It is estimated that the later collection of timber from CF, LHF, and government-managed forests (for homeuse and individual sales) exceeds commercial timber sale. Fuelwood has become the synonym for energy, particularly in the rural and residential sector of Nepal just because of its huge contribution in the total energy system, a situation that is likely to prevail for long time for foreseeable future.

#### 4.2 Wood-Based Industries

Katha factories, nemo parquet factory, cottage and large scale furniture industries, sawmills, plywood, and pulp factories generate huge magnitude of employment to the poor, semi-skilled, and skilled people as a major source of livelihoods.

**NTFP-Based Industries and Small Enterprises:** In inventory of ANSAB shows that over 1000 NTFP enterprises are involved in the processing of NTFPs/MAPs all over the country. Non-Timber Forest Products (NTFPs) are the traditional source of food, fiber and the medicine. In rural hilly areas, it contributes upto 50% of total annual income. The NTFP sub-sector in Nepal contributes about 5% of the national Gross Domestic Product (GDP) out of a total of about 15% from the whole forestry sector (Banko Janakari, 2004).
Resin Factories: There are now 13 resin factories mostly located in mid- and far western regions that process pine resin into turpentine and other by-products. It generates huge amount of employment and the source of income for the poor as a major source of livelihood.

Eco-Tourism in the Protected Areas and Food Security: On an average 145,351 tourists visited the protected areas that include national parks, wildlife reserves, hunting reserve, and conservation areas. Such tourists create a huge amount of employment at a national and local level and promote local cottage industries, communication services and in many other ways. It is a good source of clean green dollar in Nepal. However, the forestry sector only get entry fee in the protected areas. Other aspects of benefits and contribution of the forestry sector seems low and it is time to revisit the accounting system of ecotourism and the whole forestry sector.

4.3 Buffer Zone Program and Food Security

Altogether there are 11 buffer zones around the protected areas declared by the Government of Nepal, which include 112,125 households and 714,098 populations of 183 VDCs of 27 districts (DNPWC, 2007). The buffer zone (BZ) program includes community development program in the form of road/trail construction/improvement, skill development, and income generating program for women and poor contributing directly to food security. The BZ communities also receive 30-50% of the revenue from the protected areas, however, it is yet to assess the contribution of the buffer zone program in food security.

4.4 Community Forestry and Food Security

Community forestry and income generating activities directly and indirectly contributes to food security. Many community forest user groups have launched pro-poor programs to uplift the socioeconomic condition of the poor households, particularly in the districts supported by external funded projects such as the Swiss Development Cooperation (SDC) and the Livelihoods and Forestry Programme (LFP). They identify the poor households, allocate them chunks of community forest areas for income generation and offer loans at low rate, and also skill development training for capacity development. However, these measures have not been adopted in all community forest user groups. In addition, poor households are also given the opportunity in harvesting, processing and transporting timber, logs and forest products from community forests providing them employment and income. Community forestry is the largest area with a high potentiality to contribute in food security.

Niraula (2004) found that the average value of forest products harvested from the community forests in Nepal is NR 1728.00 per hectare. The study was carried out in 1788 community forests out of which 247 CFs from Terai, Inner-Terai and Siwalik region, and 1541 CFs from hills and mountain regions. Total economic value of harvested products from 12,19,272 hectares community forests was estimated NRs 2106.90 million. It includes only timber, firewood, grass/fodder/bedding material, medicinal and aromatic plants, pine resin, other forest products but it does not cover the economic value of ecological functions, ecotourism, carbon sequestration, biodiversity, and scenic view.
4.5 Leasehold Forestry for Poor

The leasehold groups are leased out degraded forest areas for 40 years. This is one of the most effective programs for the livelihood improvement of the poor. In 22 mid-hill districts, it focuses on income generation through livestock and in 11 Himalayan districts, the focus is income generation of poor households mainly through non-timber forest products and skill development.

Illegal Hunting of Wildlife: Hundreds of wild animals mainly deer are killed for meat as a source of nutrition. In Jumla, piglets of wild boar are caught during the wildfire season and grown as pet pigs. The meat of such pet boar is expensive than other kinds of meat.

Wild Fruits, Vegetables and Yams: Wild fruits, vegetables and yams are a good source of nutrition for the poor but they are not accounted in the national economy and the forestry sector contribution.

Bhorola and Sal Leaves: Bhorola leaves and Sal leaf plates are collected and sold in local markets, Kathmandu and in a certain Terai community as main source of livelihood. In Arun Khola of Nawalparasi district, large numbers of poor households collect Sal leaves, make leaf plate (hand-made Tapari) and sell which provides about 8 months' employment.

Bamboo and Sabai grass: Churia hills are a good source of bamboo and Sabai grass collected from wild for homeuse and sale in the local market during off-agriculture season in Dhanusha, Mahottari, Siraha districts. Sabai grass is also a high quality raw material for making paper.

4.6 Dependence of Indigenous Peoples on Forests

The Chepangs people 0.23 percent of the total population are one of the twelve highly marginalized indigenous nationalities numbering 52,237 (Census, 2011). The majority of them inhabit scattered settlements in forests in remote, steep terrains and inaccessible hills of Chitwan, Makwanpur, Dhading, and Gorkha. Currently, they practice sedentary and subsistence rainfed agriculture on marginal lands. Only a small percentage of the Chepang households are self-sufficient. Food insufficiency and food insecurity are identified as the most serious issue among the Chepang, Bankariya, and Raji communities who depend on wage laboring, gathering forest products for self-consumption and sale on small livestock for cash income. Most of their income is spent on procuring food. They also depend on other communities for loans. Forest plays an important role in the livelihoods of Chepangs since it provides not only staple foods that help them to overcome food shortages but also a number of dietary elements through supplemental food. Collection of forest products is important for them, since they are unable to obtain sufficient income from farming alone and other non-farm income opportunities for earning are absent or very limited in their settlements. Furthermore, agriculture and livestock which form mainstay of their livelihood also depend largely upon forest resources. But forest products often fail to fetch significant monetary values as most of the products are use for self-consumption (e.g. wild tubers) or for the consumption of livestock (fodder, leaf litter) and economic value often remain ignored (Maharjan and Chhetri, 2006).
Food self-sufficiency and food insecurity is the most prominent issue in the livelihood of Chepang community. They adopt multi-pronged livelihood strategies like wage labour, collection of forest products, rearing small livestock, selling bamboo handcraft, agriculture and forest products. Insecure land tenure and lack of citizen certificates is important issue for most of them. Unfavorable forest policies that restrict their access to forest resources further threaten their livelihood (Limbu, 2005; Uprety and Adhikari, 2006).

Cultivation of forest-based products for poor household and their food and nutrition security remains to be explored. Furthermore, there is also need to include food and nutrition security indicators in the forestry sector. Drum sticks, *Dioscorea* (Githa and Vyakur), pine apple, banana, wild vegetables, honey, bamboo, *Nigalo* are short-term species that can provide food products on annual or seasonal basis to the forest dependent people. Katahar (jackfruit), Badahar (*Artocapus lakoocha*), Lapsi (*Choerospondias axillaris*), Imli (*Tamarandus indica*), Chiuri (*Bassia butyracea*), Amla (*Phayllanthus emblica*), Jamun (*Eugenia jambolana*), Koiralo (*Bauhinia purpurea*), Kafal (*Marica esculenta*), Timur (*Zanthoxylum armatum*), Tejpat (*Cinnamomum tamala*) supply food products to them in a long-term basis.

**Bankariya:** Bankariya is one of the highly marginalized indigenous nationalities of Nepal. Bankariyas are animists who worship nature and their ancestors. They collect seasonal roots and fruits from forest and work as labour. They make bamboo baskets, mattresses, and wooden containers and barter these items with grains in the nearby communities. Another source of their cash income is medicinal herbs which they collect from the forest and sell. Most of them are uneducated but their children are going to school.

**Raji:** Historically Raji communities are nomadic. Their population is 2,399 as of Census 2011. They are distributed in Bardia, Kanchanpur, Surkhet and Kailali districts. The major sources of their livelihoods are agriculture, collection of forest products, fishing. They get NRs 1000 per person per month from the Nepal Government as allowance which is not adequate to sustain. They do not have easy access to forests. About 50% of them have not been displaced from the Bardia National Park.

5. **Conclusion**

Chepangs, Ruate, Raji and Bankariya are forest dependent communities who frequently suffer from starvation, malnutrition, and famine. Some project such as leasehold forestry for poor, community forestry and buffer zone programs have been launched that have contributed in food and nutrition security. Similarly, the collection and sale of non-timber forest products and medicinal and aromatic is other endeavor in the forestry that also contributes in food and nutrition security. Moreover, forest product-based enterprises and industries also create employment opportunities in the forestry sector for the livelihoods of the semi-skilled and skilled people.

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Effects of Taxing on Bribing in Agro-processing Enterprises in Nepal

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Abstract

Paying bribes in getting public services and utilities is considered to be bad as it decreases the reputation of the public agencies and efficiency of service delivery and the economy. Information on temptation and compulsion in paying bribes can help in anti-corruption policymaking. This paper, using bribe paying data from a survey of 415 agro-processing enterprises in operation in five districts in Nepal, estimates the effects of tax policy on paying bribe for getting public services. Ordinary least square estimates are used on firm level data to estimate the effects of tax policy on bribing and investments controlling fixed effects related to the industry and geographic areas. The results show that taxes, fees, and fixed costs are among the major factors inducing temptation in paying bribes. Firms in some industries and districts pay larger amounts of bribes than others. The results may help in developing targeted policy measures in controlling corruption.

Keywords: Agro-processing enterprises, bribe, Nepal, Tax policy

JEL Code: D73

1. Introduction

Corruption is widely understood as the misuse of public power for private benefit and involves money-changing hands. A widely used narrative is that corruption is a transaction between the private and the public sector actors through which collective goods are illegitimately converted into private-regarding payoffs (Heidenheimer et al., 1989:6). The World Bank has identified corruption as the single greatest obstacle to economic and social development. Corruption undermines development by distorting the rule of law and weakening the institutional foundation on which economic growth depends.33

Bribing is the form of corruption that is the most visible to the common people. The direct sufferers of bribing practices are weaker sections rather than the people with political or other power and as a result, the rich and corrupt become even richer at the expense of the honest and poor. The distributional consequences of bribing can trigger resentments in the majority of the ordinary people, particularly among those who are weak but aware of their rights of receiving

public services. But due to the lack of information on marginal estimates these distributional effects are not easily linked to public welfare as economists commonly define it. There is a growing empirical literature mostly based on comparative country studies, highlighting that corruption lowers investment, capital productivity, capital inflows, and many other macroeconomic data that are relevant to public welfare (Lambsdorff, 1999a). High costs of doing business have impeded investment in productive sectors increasing unemployment and out-migration of youths. All these problems suggest a grave need for reducing corruption for making public service delivery smooth and increasing human welfare in the country.

Public policies in Nepal emphasize commercialization of the hitherto largely subsistence agriculture. A major effort in the commercialization of agriculture is to promote agro-processing enterprises that create demand for farm products providing price incentive to farmers to grow more food and other raw materials. Although the primary agricultural productions are not taxed, the tax policy is not lenient toward the registered agribusinesses. Establishment and operation of such agro-processing enterprises need permission from government line agencies and in the case of utilities, from parastatal institutions with some prescribed fees. The entrepreneurs of agro-processing firms often claim that they have to pay bribes to get such services. Citizens, particularly after the declaration of multiparty democracy in 1990 and republic in 2009, better understand their rights and demand better performance from government service providers. They are now increasingly aware of the costs of poor management and corruption in the public service providing institutions. The quality of the government is often rated with respect to corruption levels that affect the predictability of policymaking and reliability of implementation. Minimization of corruption is thus emerging as an urgent need for realization of the agricultural commercialization policy and agricultural development in the country.

Demand for bribe in public service delivery is beyond the scope of this paper which focuses on the effects of taxing on paying bribes to avail public services. This paper quantifies bribe payments made by agro-processing entrepreneurs to government line agencies and other utility providing agencies and tests whether the level of taxes and fees affect the payment of the bribes.

2. Methodology

The study tested hypotheses that (i) Taxing affects the level of bribing; (ii) Bribing is directly proportional to sunken costs; and (iii) The nature of the business also affects bribing. The study tested the hypotheses mainly on the basis of primary data obtained from a survey of 500 agro-processing enterprises selected randomly from purposively selected five districts in Nepal, namely, Kathmandu, Lalitpur, Bhaktapur, Chitwan, and Nawalparasi where a majority of such agro-processing enterprises are concentrated. The list of agro-processing enterprises was obtained from the registration and renewal registers maintained by the registration agency of the government. However, 85 enterprises were found closed and the analysis is based on the data from 415 agro-processing enterprises. The enterprises registered during the year 2001 – 2006 formed the sampling frame. From the sampling frame thus constructed, the sample enterprises were selected randomly from five sample districts. The sample was allocated to the districts and
the types of the enterprises following the probability proportionate to the size. The number of agro-processing enterprises surveyed is given in Table 1.

Table 1: Type of sample enterprises surveyed

<table>
<thead>
<tr>
<th>Type of enterprises</th>
<th>Kathmandu</th>
<th>Lalitpur</th>
<th>Bhaktapur</th>
<th>Chitwan</th>
<th>Nawalparasi</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food processing</td>
<td>24</td>
<td>25</td>
<td>4</td>
<td>16</td>
<td>5</td>
<td>74</td>
</tr>
<tr>
<td>Spices processing</td>
<td>30</td>
<td>13</td>
<td>10</td>
<td>13</td>
<td>10</td>
<td>76</td>
</tr>
<tr>
<td>Food manufacturing</td>
<td>31</td>
<td>26</td>
<td>9</td>
<td>14</td>
<td>7</td>
<td>87</td>
</tr>
<tr>
<td>Poultry farming</td>
<td>14</td>
<td>8</td>
<td>8</td>
<td>26</td>
<td>4</td>
<td>60</td>
</tr>
<tr>
<td>Grain mill</td>
<td>28</td>
<td>13</td>
<td>25</td>
<td>44</td>
<td>64</td>
<td>174</td>
</tr>
<tr>
<td>Oil mill</td>
<td>6</td>
<td>9</td>
<td>0</td>
<td>6</td>
<td>7</td>
<td>28</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>133</strong></td>
<td><strong>94</strong></td>
<td><strong>56</strong></td>
<td><strong>120</strong></td>
<td><strong>97</strong></td>
<td><strong>500</strong></td>
</tr>
</tbody>
</table>

The types of agro-enterprises included in the study are food processing enterprises (food processing, jam, jelly production), spices processing (grinding and packing spices like ginger and turmeric), food manufacturing (bakery, noodle, dalmoth), poultry farming, grain mills, and oil expeller mills. The sample enterprises were surveyed using a structured questionnaire in the year 2007.

Reinikka and Svensson (2006) discuss the survey techniques aimed at a better measurement of corruption at the micro-level and claim that collecting quantitative micro-level data on corruption is possible with appropriate survey methods and interview techniques. Following their recommendations, the entrepreneurs were asked how much bribe they paid for getting service from public line agencies and utility providing parastatal organizations. Direct firm-level data were used to estimate the amount of the bribe paid. The sample was post stratified on the basis of ethnicity of entrepreneurs of agro processing enterprises. Multiple regression model was used to estimate the effect of taxes and fees on volume of bribe paid to discover the factors affecting the amount of bribe payments to obtain public services.

**3. Theory of Causes and Consequences of Corruption**

**3.1 Vicious Circle of Bribing, Defaming and Inefficiency**

Nepal is trapped in a vicious circle of bribing. Poor institutional conditions and their inadequacies provide a fertile ground for corruption to flourish. For the client, a tradeoff exists between administrative delays and bribing in the case when public service delivery is not timely and efficient. Given the excess demand for public goods and services over the supply capacity of the public sector, applicants for services have to wait long for their turn. The files get piled and not processed according to the needs of the applicants. Low paid, improperly positioned, less trained, and less motivated employees have no enough zeal and enthusiasm to provide services efficiently. The resulting waiting costs of clients increase with increase in the opportunity costs of their time. For clients, the costs of transaction can be reduced if the payment of speed money can induce bureaucrats to increase their efforts and process cases according to urgency, a need which might be measured by the applicants’ willingness to pay (WTP) for getting the job done quickly (Figure 1). But, they are often not the basis but themselves a consequence of corruption.
(Lambsdorff, 2001a). However, Myrdal (1968a: 952-3) opposed this by arguing that the corrupt officials might, instead of speeding up, actually cause administrative delays to attract more bribes. A similar proposition is put forward by Rose-Ackerman (1978: 90), arguing that bureaucrats behave like monopolists who profit from increasing prices by creating scarcity of services. To the contrary, with the help of a formal model, Lui (1985: 773) argues that the effort required for a bureaucrat to serve a client represents a disincentive and induces the tendency to avoid the norm among the bureaucracy. Lambsdorff (2001b) reports that the total effect of corruption cannot be determined a priori, but depends on the size of externalities. A similar conclusion can be drawn for a minor case of corrupt misdeed, the payment of speed money. A vicious circle of inefficient regulation emerges, leading to corruption, which in turn cultivates the further spread of the tendency to enhance administrative power and opportunity to exact further payoffs.

A vicious circle of bribing and law making is thus clearly visible. Increased corruption perception increases the need for anticorruption law making. We put lots of efforts in controlling corruption by increasing legal provisions, standards, guidelines, terms, and conditions for service delivery. Increased regulation of it makes difficult for the client to comply with the regulations. When prospective service recipients feel that it is very difficult to comply with all the sets of rules and regulations, they ultimately resort either to availing a political power or paying bribes direct to service providers or some intermediaries who have established linkages with service providers. Increased regulation ultimately breeds a group of intermediaries who, in addition, spread the fear of law among the general people distancing the service seeking people from the service providers. As a result, even those service providers who are ready to provide services most sincerely and austerely, are distanced by the intermediaries who put efforts in defaming the agency increasing corruption perception among the general people.

### 3.2 Causes of Corruption
Empirical work on corruption relies more on detailed questionnaire survey. The World Bank has developed such questionnaires. The enterprises are asked how large shares of their expenditures are paid out in bribes, whether they try to bribe to put forth advantageous laws, and whether they pay out bribes to win single contracts (Hellman et al., 2000). The direct, firm-level data from the World Bank are briefly presented in Wei (2000) and applied in Kaufmann and Wei (1999). Most of the data published have so far focused on the so-called transition countries. Svensson (2000), however, applies firm-level data from Uganda, based on the Ugandan Industrial Enterprise Survey, initiated by the World Bank but implemented by the Ugandan Manufactures Association. Empirical research on corruption has for long been hampered by the lack of reliable data. This has been partly rectified by Transparency International bringing into the public domain the results of mainly commercial risk analysis institutes. This has until now mainly consisted of quantification and indexation of rather vague and loosely structured conceptions of corruption. Economic perspectives and quantitative analyses of the causes of corruption are fairly new undertakings. Lambsdorff (1999b) provides a comprehensive review of the literature on empirical research about the causes of corruption, focusing on political institutions, government regulations, legal systems, GDP-levels, salaries of public employees, gender, religion and other cultural dimensions, poverty, as well as the role of colonialism. Most of this econometric research assumes as a first approximation independent variables causing corruption without feedback from corruption itself. Moreover, there is little discussion of any interesting interaction patterns among the causal variables. It is often difficult to assess whether corruption causes other variables or is itself the consequence of certain characteristics (Lambsdorff, 1999b). Empirical research based on various corruption indexes reports correlation between certain forms of government regulations, poor public institutions, poverty, and inequality. But conclusions with respect to causality remain blurred. A major obstacle to cross-national comparative empirical research is the difficulty of measuring levels of relative corruption in different countries. A number of econometric studies using Corruption Perception Index (CPI) and Bribe Payers Index (BPI) as explanatory variables examine historical, cultural, political, and economic determinants of a variety of indicators of government quality, including corruption (La Porta et al., 1999; Paldam, 1999; Treisman, 2000). Cross-country ratings – based on the respondents’ perceptions – are by definition subjective. However, empirical work confirms that subjective evaluations of corruption do themselves appear to influence investment decisions, growth, and the political behavior of citizens (Mauro, 1995). The most widely used index in regression analysis, i.e., Transparency International’s CPI, correlates positively with the size of the unofficial economy as estimated by Johnson et al. (1998).

In terms of analytical approach and methodology, Lancaster and Montinola (1997) suggest that comparative research on corruption should include three related tasks: (a) provision of causal explanation of co-variation among cases and correlation between corruption and other variables, (b) development of theoretical models that incorporate differences in context in order to illuminate causal relations, and (c) empirical verification of theoretically derived models or regressions to estimate numerical values for coefficients in theoretical models. Similarly, Paldam (1999) presents the cross-country pattern in CPI as explained by a combination of cultural and economic variables. He constructs a simple one-equation function that can be separated into an
economic and cultural sub-model. The regression analysis is initially conducted separately for the two sub-models. The corruption variable is presented by the CPI. Subsequently, the entire model is explored in a multiple regression analysis. Interestingly, the conclusions differ between the sub-model regressions and the full-model regressions. The study finds dynamic changes in corruption level within individual countries. It explains these changes by a seesaw effect where the level of corruption in a country moves toward a high or low equilibrium depending on the initial situation. This seesaw effect is consistent with the theoretical models of multiple corruption equilibria, for instance, the one developed in Andvig and Moene (1990). Treisman (2000) follows the research approach outlined by Paldam (1999). This article is probably the most comprehensive quantitative analysis available on the causes of corruption. His point of departure is corruption perceived to be more widespread in some countries than in others. Economists and political scientists have suggested a variety of characteristics of countries’ economic, political, cultural, and social systems that may affect the expected costs and benefits of corruption for individual officials. Thus, by assuming rational behavior, corruption can be modeled as a gamble where the public official is weighing the expected benefits from a successful act of corruption against the expected costs (including social, psychological, and financial costs). Decrease of honesty in the society is a major cause of corruption. Paldam (1999) reports that household honesty is a good with high income elasticity. The demand for honesty increases with income levels. For firms, honesty is a time saving device that becomes more necessary as countries grow rich. Thus, honesty is hypothesized as a production factor. An additional reason to expect that corruption might decrease with economic development is related to social stigma. Some scholars argue that the social stigma facing corrupt officials if exposed, changes with economic development. Ekpo (1979), for instance, suggests that in traditional societies, where the lines between public and private are less clearly drawn and where gifting is not clearly distinguished from bribery, social stigma may be lower. Thus, it is argued, the attempt to apply traditional norms and practices to a modern market-based economy is a modus operandi for corruption with lower costs of stigma.

In cross-country regression analyses, Paldam (1999) and Treisman (2000) find that by far the most important determinant of corruption is economic development, measured by real GDP per capita. Causation runs from economic development to lower corruption, and from corruption to lower economic development. Corruption and levels of economic development are related. Misuse of public office is more likely to be exposed in more economically developed countries where media are strong. Rich countries are, relatively spoken, efficient countries, where transactions have to be fast and transparent. Assuming that the society considers corruption as an illegitimate and undesirable act, one may tend to argue that the negative externalities of corruption outweigh the gains. But where poor institutional preconditions and extensive distorting regulation exist, some economists would rather downplay the size of these externalities and favor corruption as a means to open up new contractual possibilities (Ades and Di Tella, 1999).

In literature, the linkages between corruption and democracy are not obvious. For instance, competitive politics may escalate the demand for campaign funds, and thus be a breeding ground
for questionable political influence (Goldsmith, 1999). Political candidates may sell their political influence to the biggest donors. On the other hand, the risk of revealing corrupt officials is higher in more democratic, open societies (Diamond and Plattner, 1993). Greater civic engagement may lead to closer monitoring an exposure of civil servants and politicians. In democratic systems, people through free elections may avoid voting for corrupt politicians. A number of empirical studies have explored the possible correlation between corruption and democracy (Harris-White and White, 1996; Paldam, 1999; Goldsmith, 1999; and Treisman, 2000).

The redistribution of power between the center and the periphery is another possible determinant of corruption. Some studies argue that concentrated power is an aggravating factor in corruption. Proudhon (1963:48) contends that the centralized state, instead of serving its citizens, expropriates and crushes them. It is also argued that bringing government to the door of the people through decentralization could mitigate these problems (Wunsch and Olowu, 1990; Enemuo, 2000; Rondinelli et al., 1989; Oates, 1972). Since everyone tends to know everyone else’s business in decentralized settings, it is harder to conduct under-the-table deals (Goldsmith, 1999). Due to social pressure, local officials may thus be less prone to cheat or abuse people they know and live near.

However, the empirical studies of the linkages between corruption and decentralization in developing countries are relatively few. In a case study from Tanzania, Fjeldstad and Semboja (2000) find that fiscal administrations in many local authorities are highly corrupt, partly due to the extreme degree of discretionary powers of local officials, and poor monitoring from the center. In a cross-country regression analysis based on corruption perception indexes, Goldsmith (1999) suggests that federal or decentralized systems are not favorable settings because they make it easier to hide corrupt practices or even intimidate whistleblowers. These results are supported by Treisman (2000) who finds that federal states are more corrupt than the unitary ones.

Literatures also link public sector salaries and recruitment policies with the corruption. Rijckehehm and Weder (1997) explore to what extent the level of public sector salaries is linked to the level of corruption. Their basic argument is that low salaries force public officials to supplement their incomes by taking bribes, while high salaries imply higher alternative costs if detected for fraudulent behavior. If public sector wages were doubled, the corruption index of a country will be improved by the order of 2 points in the corruption index (CPI) of Transparency International. However, there may be a problem of causality in their analysis since corrupt (and poor) countries tend to have poor budgetary performance and, thus, may keep civil service wages low, as a consequence. Rauch and Evans (2000) do not find robust evidence for any impact of public salary levels and corruption.

International openness and trade is believed to affect corruption. Wei (2000a) tests the claim that low trade volumes are one of the roots to corruption, rather than one of its consequences. Broadman and Recanatini (2000) include the effects of trade openness in their study of the effects of market institutions on the degree of graft in a sample of transition countries. Again the
effects of what is denoted ‘residual’ openness are surprisingly weak. Countries with high corruption levels have lower shares of foreign direct investment (FDI) in their foreign (gross) debt stock, and low FDI levels altogether (Wei, 2000b).

The causes of corruption explored are thus the level of economic development, political rights and democracy, federalism and decentralization, public sector salaries and openness to international trade. This reflects the current state of the empirical studies on corruption that have so far, with few exceptions, been restrained to studies of what explains corruption. But, literatures are scanty to describe the effects of tax policy on bribing.

### 3.3 Consequences of Corruption

Corruption can make economic transactions inefficient, slow, and sometimes unpredictable (Schleifer and Vishny, 1993 and Myrdal, 1968b). Literature claims that corruption harms economic development. From this line of partly theoretical arguments and intuition, political scientists and economists have derived hypotheses on the linkages between corruption and economic development.

An important line of thinking in the corruption literature argues that the economic benefits of corruption outweigh the costs (Leff, 1964; Nye, 1967; Huntington, 1968). One point often made is that bribery greases the wheels by cutting red tape, and thus improves efficiency. The argument that corruption improves efficiency is based on the assumption that the economic costs of extensive public regulations may be reduced or avoided through bribery. Using data from three worldwide firm-level surveys, Kaufmann and Wei (1999) examine the relationship between bribe payment, management time wasted with bureaucrats, and the capital cost. Contrary to the efficient grease theory, they find that firms that pay more bribes are also likely to spend more, not less, management time with bureaucrats negotiating regulations, and face higher, not lower, cost of capital. Positive and negative effects of corruption are both plausible, and without a systematic review of evidence there is not much basis for deciding which side gets the better of the argument (Goldsmith, 1999).

It is likely that increased number of regulations is associated with the level of corruption. But, it is not clear whether corruption leads to extensive regulations or vice versa. Some scholars argue that extensive public regulations are the result of a deliberate strategy by civil servants to increase their clients’ willingness to pay bribes (Myrdal, 1968c; Rose-Ackerman, 1978; Tanzi, 1998). Assuming that bureaucrats are driven by rational, self-serving motives, the logical presumption is that they will seek even more ways to create bribe-producing delays in the work. This line of reasoning may also contribute to explain observed resistance from bureaucrats for public sector reforms. For instance, Myrdal (1968c) argues that corrupt officials, instead of speeding up, actually caused administrative delays to attract bribes.

In other cases, many regulations may be introduced in genuine efforts to avoid corruption, in which they may be at least partly successful. Nevertheless, an observed covariation between corruption and extensiveness of regulations may be observed, but in this case the main causal
link is from corruption to regulation, not from regulation to corruption. Similarly, Winters (1996:166) finds the strongest resistance to tax reforms in Indonesia from the tax officials themselves, since they had the most to lose from the depersonalisation and simplification of the tax system. Flatters and Macleod (1995:409), also referring to Indonesia, assert that tax collectors actively opposed simplification in property tax administration, income tax laws, and tariff structures.

An influential empirical study of the impacts of corruption by Mauro (1995) attempts to identify the channels through which corruption and other institutional factors affect economic growth, and to quantify the magnitude of these effects. He finds that corruption has a negative impact on the ratio of investments to GDP, its investment rate. According to the study, a more precise indicator of corruption is the simple average of three of the indicators, i.e., the judiciary system, bureaucratic red tape, and corruption. These three indicators correlate well, and by aggregating them into a composite index bureaucratic efficiency the risk of measurement errors is expected to be reduced.

This review of the theory of causes and consequences of corruption leads to conclusion that there are several studies of cross-country comparison of corruptions, particularly using the corruption index and GDP, but the micro-level studies on corruption relating to the fiscal status are very limited.

4. Results

Each agro-processing enterprise is found to visit two types of organizations for completing the formalities and facilitating to establish the production unit. The organizations of the first type are statutory agencies that enforce legal provisions that the enterprises are required to comply with. The organizations of the second type are those that provide service to enterprises and the services are generally necessary for profitable running of the enterprises. The first category of the institutions provides services like registration of firm, permission to establish enterprise, permission for starting production, renewal of permission, quality control, and paying the taxes. The second category includes the organizations that need to be visited by the enterprises to get loan and to get utilities such as electricity, telephone, and water connections.

4.1 Hassles in Receiving Public Services

Entrepreneurs are concerned with ten agencies for registration of various agro-enterprises (the names of the agencies concerned are not disclosed for the purpose of anonymity). The average legitimate fee and tax for registration of each of the enterprises is Rs 1,986, ranging from Rs 3 to Rs 25,000. On an average, each enterprise pays Rs 184 as an illegitimate payment to the statutory institutions to get the firm registered. Some entrepreneurs even feel embarrassed to pay the small amount of bribe directly to the employees, increasing their temptation for hiring an agent. Among the payments made by the entrepreneurs to the agents, a part goes to the agent as fee and the rest might go to the service provider. For the enterprises, the amount paid to the agent is less than or equal to the hassles and other costs they have to face and incur.
Aspirant agro-processing entrepreneurs who want to set up a processing plant have to meet several criteria of firm registration and production unit establishment based on the type of the commodity they want to produce. These multiple agencies are both the cause and the effects of bribing. When the government sees some undesirable practices, it tries to add a new agency and/or legal provision to control such activities. In effect, the entrepreneurs find difficulties in meeting all the requirements and try to find some shortcuts through bribing. It is evident from Table 2 that an agro-processing enterprise in Nepal, on an average, needs to visit ten agencies for meeting formalities for firm registration and ten others for permission to establish the production unit. It also needs to visit several agencies for getting connected with utilities such as water, electricity and telephone, and permission on starting the production, and also for the renewal of permissions. The time taken and costs incurred for getting permission and services from each agency are large. It is evident that the frequency of visits and time taken are lower in renewal compared to those in the initial permissions. The travel costs per visit, including the fare and opportunity costs of the time spent, affect bribing and bribing can reduce the number of visits necessary. The total travel cost for firm registration is higher than the legitimate fees and taxes the entrepreneur has to pay. This is also true for the permission for starting production. It means the transaction costs for firm registration and other formalities are much higher than the formal fees prompting the entrepreneurs to pay bribes to reduce such transaction costs. The high travel cost increases the temptation of entrepreneurs to pay bribes.

Table 2: Hassles and payments for completing tasks from statutory institutions (N=500)

<table>
<thead>
<tr>
<th>Particulars</th>
<th>Unit Registration of firm</th>
<th>Permission to establish enterprise</th>
<th>Permission for starting production</th>
<th>Renewal of permissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agencies visited by entrepreneurs</td>
<td>No</td>
<td>10</td>
<td>10</td>
<td>5</td>
</tr>
<tr>
<td>Number of visits per case</td>
<td>No</td>
<td>42.54</td>
<td>33.59</td>
<td>12.14</td>
</tr>
<tr>
<td>Time taken for each visit</td>
<td>Minutes</td>
<td>51.57</td>
<td>4.36</td>
<td>2.78</td>
</tr>
<tr>
<td>Travel fare for each visit</td>
<td>Rs/visit</td>
<td>33.86</td>
<td>1.48</td>
<td>0.67</td>
</tr>
<tr>
<td>Travel costs for the entire process</td>
<td>Rs</td>
<td>2354.48</td>
<td>110.74</td>
<td>22.20</td>
</tr>
<tr>
<td>Legitimate fees and taxes</td>
<td>Rs</td>
<td>1985.84</td>
<td>159.96</td>
<td>6.20</td>
</tr>
</tbody>
</table>


4.2 Taxes and Fees Affecting the Supply of Bribes

On an average, an agro-processing firm pays Rs 4810 in bribe to meet the formalities of registration, operation, and renewal. The agro-processing enterprises are small in nature with an average fixed cost of less than one million rupees. The operating expenses are still smaller. The rent paid and the costs of raw materials just exceed a half million rupees (Table 3). As most of the enterprises are family operated, labor employment is not included in the study. The gross return per annum is also less than one million rupees. The large revenue as compared to the fixed investment shows that most of the agro-enterprises are low technology enterprises with small machines. The size of the tax and fees paid to the government is about Rs 22,480. This is because the primary agriculture products are not taxed in Nepal. For processed agricultural products too, the taxes on cottage and small agro-enterprises are low.
For quantification of the hassles the agro-processing enterprises face from the regulatory agencies, an indirect approach was followed. A hypothetical private agency 'SERVASEVA' is thought to complete all the government formalities for any enterprise within one day. But, the fees and taxes of the government or other agencies as usual are to be paid by the concerned enterprises. If any enterprise orders SERVASEVA by a phone call, it will collect the required papers and normal government fees and taxes from the enterprise and complete all the formalities from all government offices within a day. The entrepreneurs were asked to bid for a payment to this hypothetical agency. The average willingness to pay (WTP) is Rs 1,822 per enterprise with a range from zero to Rs 48,000. WTP is much lower than the tax and fees because the WTP was asked from the existing agro-enterprises and they have already completed the registration formalities and they know how to complete the renewal formalities. The hassle faced by the agro-processing enterprises during the early stages of the establishment is, however, not counted by this measure.

Table 3: Descriptive statistics of size of firms and bribing variables (N=415)

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bribe (aggregated)</td>
<td>4809.78</td>
<td>1716.08</td>
<td>0.00</td>
<td>301000.00</td>
</tr>
<tr>
<td>WTP for a hypothetical agent-Servasewa</td>
<td>1821.74</td>
<td>3995.67</td>
<td>0.00</td>
<td>48000.00</td>
</tr>
<tr>
<td>Tax and fees</td>
<td>22,480.45</td>
<td>27285.13</td>
<td>0.00</td>
<td>248100.00</td>
</tr>
<tr>
<td>Fixed costs (Rs 1000)</td>
<td>46.50</td>
<td>74.43</td>
<td>0.00</td>
<td>681.35</td>
</tr>
<tr>
<td>Variable costs (Rs 1000)</td>
<td>919.62</td>
<td>1833.27</td>
<td>30.78</td>
<td>20011.85</td>
</tr>
<tr>
<td>Food processing (Fruits and vegetables)</td>
<td>0.15</td>
<td>0.36</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Spices grinding and packing enterprises</td>
<td>0.14</td>
<td>0.35</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Food manufacturing (Bakery/noodle/dalmoth)</td>
<td>0.17</td>
<td>0.37</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Poultry farms</td>
<td>0.11</td>
<td>0.32</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Oil mill</td>
<td>0.06</td>
<td>0.24</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Grain mill (base category)</td>
<td>0.36</td>
<td>0.48</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Lalitpur</td>
<td>0.19</td>
<td>0.39</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Bhaktapur</td>
<td>0.10</td>
<td>0.30</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Chitwan</td>
<td>0.25</td>
<td>0.44</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Nawalparasi</td>
<td>0.19</td>
<td>0.39</td>
<td>0.00</td>
<td>1.00</td>
</tr>
<tr>
<td>Kathmandu (base category)</td>
<td>0.27</td>
<td>0.45</td>
<td>0.00</td>
<td>1.00</td>
</tr>
</tbody>
</table>


The higher the taxes and fees payable by the enterprises, higher is the payment for bribes. Every rupee increase in the tax and fee increases the bribe amount by Rs 0.10 (Table 4). Bribing also increases with increase in the sunken costs. Every thousand increase in the fixed costs increases the bribe paid by Rs 67. This means that the higher the sunken costs, higher are the urgency to pay bribes for official formalities. The amount of bribe paid is significantly lower in Chitwan district compared to that in Kathmandu. It shows that Chitwan district has advanced in good governance. This may be the reason that many agro-processing enterprises are emerging in Chitwan. The bribe payment in other survey districts is not significantly different from that in Kathmandu. The payment of bribe, however, is not significantly different among different types of agro-processing enterprises. Dix (2011) identified a social order that maintains client-patron
relations and obligations to one’s network in a way that is directly contrary to the rule of law as the major factors of corruption in the country.

Table 4: Factors affecting the supply of bribes

<table>
<thead>
<tr>
<th>Variable</th>
<th>Bribe payment</th>
<th>WTP to Servasewa Agent</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Basic model</td>
<td>With industry fixed effects</td>
</tr>
<tr>
<td>Taxes and fees</td>
<td>0.10***</td>
<td>0.10***</td>
</tr>
<tr>
<td>Fixed cost</td>
<td>67.62***</td>
<td>65.78***</td>
</tr>
<tr>
<td>Variable costs</td>
<td>-0.11</td>
<td>-0.07</td>
</tr>
<tr>
<td>Bribe paid</td>
<td>-0.02**</td>
<td>-0.02**</td>
</tr>
<tr>
<td>Food processing enterprises</td>
<td>-999.60</td>
<td>-1854.103</td>
</tr>
<tr>
<td>Spices grinding and packing</td>
<td>-1257.36</td>
<td>-1795.179</td>
</tr>
<tr>
<td>Food manufacturing (Bakery/noodle/dalmoth)</td>
<td>-1079.60</td>
<td>-2184.617</td>
</tr>
<tr>
<td>Poultry</td>
<td>1.58</td>
<td>1473.330</td>
</tr>
<tr>
<td>Oil mills</td>
<td>-2346.11</td>
<td>-3653.450</td>
</tr>
<tr>
<td>Lalitpur</td>
<td>2892.211</td>
<td>-1146.85**</td>
</tr>
<tr>
<td>Bhaktapur</td>
<td>-866.305</td>
<td>-1311.98**</td>
</tr>
<tr>
<td>Chitwan</td>
<td>-6046.322***</td>
<td>-2117.88***</td>
</tr>
<tr>
<td>Nawalparasi</td>
<td>708.083</td>
<td>-1944.78***</td>
</tr>
<tr>
<td>Constant</td>
<td>-537.48</td>
<td>217.46</td>
</tr>
<tr>
<td>Sample size</td>
<td>415</td>
<td>415</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.140</td>
<td>0.132</td>
</tr>
</tbody>
</table>

Source: Field survey, 2007

The WTP of agro-processing enterprises for SERVASEVA is regressed with the individual characteristics of enterprises. The level of tax and fees significantly affects the WTP for the agent. Every rupee increase in tax and fees increased the WTP by Rs 0.05. The higher the fixed cost of enterprises, the higher is the WTP for SERVASEVA. Every thousand rupees increase in the fixed costs increases WTP by Rs 13. The amount of bribe paid significantly decreases WTP. Among the industries, such service agency is found to be most accepted by the spices grinding and packing enterprises. It means this type of enterprises is facing greatest hassle in completing the official formalities. The WTP of entrepreneurs in other districts is significantly lower than that in Kathmandu.

5. Conclusions and Recommendations

Bribing is a bad practice as it not only reduces the efficiency of service delivery of public agencies but also competitiveness in the establishment and operation of enterprises. The practice of bribing may have eliminated many potential entrepreneurs in agro-processing enterprises by
imposing unpredictable costs and increasing risk allowances to the cost-benefits analysis of such enterprises.

The bribes paid to public agencies with mandatory services is more damaging to the agro-enterprises than the bribe paid to voluntary transactions such as taking loans. In taking loans, for example, the loanee can compare the benefits from taking loan to the costs of the loan including the bribe amount. Moreover, the sources of loans are more than one offering alternatives. The payment of bribes is exploitative to the enterprises if the enterprises have no option but have to pay bribes if they want to be in the business. In renewal of certificates, environmental conformity, and getting electricity connected, there are no options left with the entrepreneurs except closing their enterprises. When there is no option left, the demand for bribes is higher and any hesitation on the payment delays production or reduces resource productivity. Though most of the employees of service providing agencies are honest, their honesty is less visible than the corrupt practices of a few of them. Nepalese law considers the bribe payers and receivers equally guilty. This discourages bribe payers to fight against the bribing after paying a bribe. A policy reform is necessary to empower the bribe payers to claim back their money paid as a bribe if they can substantiate the bribing. In addition, such bribe payers should also get additional compensation 20% out of the penalty changed to the bribe receiver. This provision will create mistrust between the bribe payers and receivers discouraging bribing.

Agro-enterprises are found paying bribes to complete official formalities and receive services from agencies. Most of the sample enterprises reported that they have paid bribes to the offices from which they have received the service. The actual payment of bribes increases significantly with increase in the taxes and fix costs. This means higher the tax and sunken costs, higher the urgency to pay bribes for official formalities. Therefore, policies are required to safeguard the investment incurred in the economy in productive sectors, such as agro-enterprises. The higher the taxes and fees payable by the enterprises, higher is bribe paid. This means that bringing the cottage and small agro-enterprises under the tax net will increase the risks of corruption. Public policies and tax structures governing these enterprises need to be reviewed so that the corruption can be reduced.

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References


Women’s Empowerment and Farm Productivity: A Case of Project Intervention

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Abstract

Despite substantial efforts from donors and public sector, food insecurity is still a major challenge in Nepal. Its effect seems to be more chronic with women because of deeply rooted unequal distribution practices prevalent in traditional rural communities, although working on a farm is considered as women’s responsibility. A “with and without assessment” approach had been used to compare the impact of intervention on curtailing the observed gender differentiation. Women’s access to technology transfer especially the distribution of training quota among women farmers was more equitable than male farmers as revealed through Gini coefficient. The women’s participation in skill trainings, off-farm jobs and project activities contributed to empowerment. Correspondingly, wage differentiation, women’s participation in capacity building, natural resource management, and institutional development were found to be influential in causing economic potential of women to increase farm physical productivity. Consequently, the working hours for economic activities were found to be significantly different (p<0.001) between the groups.

1. Introduction

Globally, women’s participation in labor force has increased by only 3 percent in 20 years, from 37 percent in 1970 to 40 percent in 1990. Overall, women still have only 36 percent of total wage employment and only one-third of the share of national income. Women’s wages are generally only three-quarters of men’s wages in the non-agricultural sector in 56 developing countries (Heyzer, 1995). Heyzer further states that women receive only a very small percentage of credit from formal institutions. This is particularly observable in Nepali society, because of its inherited patriarchal system. According to UNDP (2002), Human Development Index (HDI) in Nepal is low (0.48), even by Asian standards, which is only slightly above that of Bhutan and Bangladesh (0.47).

Similar to many other Asian countries, women are lagging far behind in Nepal. Socio-economic indicators such as physical survival, health and educational opportunities, ownership of assets, mobility, and overall cultural status show lower status of females. The country’s Gender-related Development Index (GDI) of 0.466 (UNDP, 2002) also proves it. Unlike GDI, Gender Empowerment Measure (GEM) of Nepal (0.38) vividly illustrates that women are far less empowered than men. The Gender-related development varies based on geographical and other
development activities. GDI is higher for urban areas (0.605) than the rural areas (0.426) because of significantly greater access to knowledge and information, health facilities, and better economic opportunities of the former.

1.1 Women in Livestock Production

Generally, farming in Nepal is labor-intensive because of its geophysical settings. It is overwhelmed by women in the labor force as they shoulder the burden of various farm activities. According to NPC (1992), 91 percent women are engaged in agricultural activities, whereas the active male population engaged in agriculture is 75 percent (in Bajracharya, p.1, 1994). Vaidya et al., (1990) suggest that women contribute to between 50 and 80 percent of agricultural labor force, depending on geographical and socio-economic variations. The contribution of women to household incomes from agricultural wage labor ranges from 10 to 53 percent (Dey, 1985). However, women farmers are not fully recognized yet as individual farmers but are referred to as farmer’s wife, sister, daughter, and daughter-in-law etc. The majority of them receive information on innovations and access to other than non-farm production inputs through their male counterparts. To date, not enough attention has been paid to appropriate technology specifically designed to help women, which is undoubtedly an important component hindering development (Gurung and Banskota, 1990). Therefore, integration of women in agriculture has become a major focus of the government.

Involvement of women in livestock production is a long standing tradition in Nepal. They play a major role in livestock production system irrespective of the eco-zones (high hills to the flat land of Terai) as their contribution is more than 73 percent of the total labor force required to livestock raising (Tulachan and Basta, 1992). According to Sharma and Awasthi (1993), women contribute 61-75 percent of the total labor required for livestock raising, depending on the ecological region and socio-economic system. The role of women particularly in livestock production, is overwhelming, though not satisfactorily addressed in the plans. On an average, 24 percent of decisions concerning livestock issues are taken by men, 11 percent by women and the remaining 65 percent by both (Shrestha, 1989). According to Karki and Bauer (2005), women’s participation in the formation of farmers’ groups (solely female, mixed) is found to be 33 percent, which is slightly higher than the 30 percent modality set in the eighth five year plan (NPC, 1992). In livestock production systems, women mostly decide on the area for fodder collection and on who does collection and feeding management for livestock during the dry season (Bajracharya, 1993). Karki (2004) mentions that respondents ranked women’s groups first, based on their active work and better progress than the mixed and men groups. Accordingly, the mixed type of group is ranked second, whereas the performance of male groups is least effective. On the same token, he mentions that 88 percent respondents reported that the functional status of women group is more sustainable compared to 83 percent and 75 percent of respondents who voted for sustainability of mixed and male groups respectively.

Although women have played very decisive roles in agricultural production, they still do not have direct access to production resources. Tisch (1992) states that access to and control of resources needs to be considered in gender concerns and benefits that contribute to family
welfare and agricultural productivity. Access is the freedom or permission to use resources, whereas control is the power to decide whether and how a resource is used. Decisions regarding management of household, along with farm and livestock production, are affected by control of resources. Management and control of these resources are important to sustainable agriculture and it is important to know “who has access to resources used for agricultural production (food crop, animal, cash crop)”. However, there is considerable evidence of women having less access to credit, technology, wage markets, and training than men in the same system (Acharya, 1989). Women lack assets that can be used as collateral and also the necessary institutional links. The lack of access to formal credit also places constraints on women in engaging in profitable self-employment, such as buying a buffalo that could earn profit or raising swine for fattening (Paris and Luis, 1991). Since women consistently contribute even more than their male counterparts in rural households, constraints on women’s access to resources steadily slows down the productivity of half of the available rural labor force.

1.2 Interrelationship between Farm Productivity and Women's Empowerment

Women empowerment is associated with gender, which has originated from inequalities observed between men and women with respect to resource, income, and power distribution. Before the 1980s, the policy agenda had been “Women in Development”. The lessons learnt during the period resulted in “Women Empowerment” and “Gender Mainstreaming” approaches. This study deals with women empowerment rather than the latter concept.

Concerning the food situation, women are the major food producers around the world. The issue of food security is becoming prominent in connection with the development endeavors since many poor people are compelled to live hungry and undernourished, despite the fact that surplus food is produced globally, sufficient food is produced with wheat yield increased by 3.4 percent (CIMMYT, 1996) and rice yield by 2 percent per year between 1969 and 1995 in developing countries (Pingali and Heisey, 1999), some 800 million people across the world still suffer from hunger and malnutrition, mainly infants and children, as well as pregnant and nursing mothers. To lessen the severity, Baumann (2000) considers the livestock sub-sector as a privileged entry point to address and promote gender issues in the rural areas of developing countries. He points out that there is a greater possibility of gender-equitable development through livestock projects in comparison to crop projects. This is because the livestock sector offers advantages over other agriculture sectors, as all household members have access to livestock, whereas access to land is often biased towards men in most societies. In contrast to crops, livestock activities are a daily occupation and animal products such as eggs and milk are produced, processed, and marketed during the whole year. As livestock production is not subject to seasonal restrictions, it is an interesting sector for promoting gender issues. Increment in livestock products serves as a major source of food self-sufficiency for a rural farm family since they can have both substitution and complementary effects on it.

Gender equity in various studies is considered as one of the major indicators for analyzing the impact of projects. This is an emerging indicator to find out how men and women of a society
benefit from project interventions. Any project that has not addressed equitable development of the various classes of a society may not be sustainable. Any development process that does not systematically address the needs of women and that of the poor is unlikely to be sustainable, since these two sectors of the society constitute together the overwhelming majority of the world’s population. Sustainable development cannot be based on a partial and inadequate understanding of a society, but must have the needs of women and the poor as a core concern (Wee and Heyzer, 1995). According to UNIFEM (1994), equitable development not only generates economic growth but also distributes its benefits equitably. UNIFEM further mentions that equitable development tends to regenerate the environment rather than destroying it and empowers people rather than marginalizing them. Such development activities give priority to the poor, enlarging their choices and opportunities and providing opportunities for their participation in decisions that affect them. It is a development that is pro-poor, pro-nature, pro-jobs, and pro-women.

This study was conducted to assess the impact on women empowerment and its effect on farm productivity of peasant smallholders. The indicators suggested by McAllister (1999) have been used to assess women empowerment at individual, group or community level in terms of strengthening local awareness of issues and options, participation in decision-making, planning and action to address problems, perception of ownership of the process, strengthening existing individual and organizational capacities, creating linkages between stakeholder groups, and empowerment in social transformation.

2. Methodology and Model Specification

2.1 Study Area and Project Intervention

The concept of leasehold forestry for the poor first emerged in Nepal only after the IFAD supported Hills Leasehold Forestry and Forage Development Project (HLFFDP) was implemented in 1991. The project objectively planned to work with small farmers, who were below the poverty line, emphasizing marginal farmers, women, and disadvantaged groups of the community. Kavrepalanchowk is one of the first districts where HLFFDP was started in 1993 and continued until 1996/97 during the project’s first phase. Three Village Development Committees (VDC) Deupur-Baluwa, Kharelthok, Sathighar- Mahendrajyoti from the project area and Nasikasthan-Sanga and Bhagawatisthan from non-project area were selected.

The focus of leasehold program was limited to specific people within the community who were below the poverty line. In general, homogenous groups of 5-9 farmers, who had less than 0.5 ha of private arable land and an annual per capita income less than NRs 2,500/- which was equivalent to US $ 44 in 1993. (NRs. is a unit of Nepal’s currency with 1 € = NRs 85 in July 2004) were selected as project beneficiaries and provided with 1 ha of degraded land (per member family) for a maximum of 40 years. The output of this land was used for individual families who were members of the group. The program implemented by the project can be grouped into five sub-headings: fodder and forage development, training and extension visits, institutional development (farmers’ group), animal health, and animal resource and management services.
2.2 Data Collection and Analysis

A household survey was conducted to collect primary data using the multi-stage random sampling procedure. A total of 120 subsistence households that comprised 60 from project and 60 from the non-project VDC of mid-hill district Kavrepalanchowk were sampled. In addition, requisite secondary data were also collected from relevant sources. Of the total respondents, 45 percent were female from the project area and 43 percent from the non-project area. The data collected were analyzed using quantitative and qualitative analytical tools.

2.3 Model Specification

The concept distribution pattern by Lorenz has been calculated (Equation 1) to measure the distributional pattern of human capital development activity between male and female farmers.

\[
G = 1 - \sum_{i=0}^{N} (\sigma Y_{i-1} + \sigma Y_i)(\sigma X_{i-1} - \sigma X_i)
\]  
(1)

Where, \(G\) = Concentration area,

\(\sigma X\) = Cumulative percentage of xs’ (x represents the number of trainees),

\(\sigma Y\) = Cumulative percentage of ys’ (y represents number of trainings)

\(N\) = Number of observations.

The overall situation of women empowerment has been expressed in the form of ordinal ranking analyzed using the ordered probit model. It is statistically more efficient than the binary logit or probit model. According to Greene (1997), the ordered probit model is formulated as follows:

\[
y^* = \beta' Z_i + \varepsilon_i
\]  
(2)

\[
Z_i = \beta_0 + \beta_1 X_i + ... + \beta_n X_n + \varepsilon_j
\]  
(3)

Where,

\(y^*\) is an unobserved phenomenon and thus can be thought of as the underlying tendency of an observed phenomenon, \(\varepsilon_i\) is assumed to be normally distributed across the observations, \(\beta'\) is a vector of unknown parameters, \(Z_i\) is the linear combination of \(X_1,...,X_n\) explanatory variables (years of schooling, access to credit, number of farm animals, skill promoting trainings, age of the household head, off-farm income, participation in project activities), and \(\varepsilon_j = \text{error term}\); \(\beta_0\) is
the intercept and $\beta_i$ is the slope parameter in the model; $Y$ is the probability of women empowerment (WOEMP) in project, where the rating scale for $Y$ is 0=very low, 1=low, 2=good, 3=very good. Here we observe,

$y = 0$, if $y^* \leq \mu_0 (=0)$,

$y = 1$, if $\mu_0 \leq y^* \leq \mu_1$,

$y = 2$, if $\mu_1 \leq y^* \leq \mu_2$, and ..

$y = J$, if $\mu_{J-1} \leq y^*$.

Here, $y$ is observed in $J$ number of ordered categories, and $\mu$ unknown threshold parameters separating the adjacent categories to be estimated with $\beta$. In order for all the probabilities to be positive, we must have, $0 < \mu_1 < \mu_2 < \ldots < \mu_{J-1}$. This suggests that respondents view the importance as ordinal numbers and the categories are indeed ordered.

3. Results and Discussions

3.1 Farm Household Characteristics

The respondents were composed of nine different ethnic groups (different castes of people socio-culturally classified in the Hindu religion). Each ethnic group differs from another in cultural norms and taboos. The participation of Newar in the survey is the highest (41.67%) followed by Tamang (20%), Danuwar (10%) and Brahmin (10%). The remaining, about 18 percent, of the project participants was shared between Kshatris, Damais, Magars, Thakuris and Paharis. The family size of farm households in project (8.4) and non-project areas is not significantly different. The literacy rate of the project farmers is 62 percent whereas it is 47 percent for non-project farmers. The literacy rate of female farmers in both project and non-project areas is lower than that of male farmers. However, a higher population of women in the project area (44%) is literate compared to non-project women (36%). The land holding size of both groups is not significantly different, but that of the holding size of the non-project farmers is slightly larger (11.74 ropani\(^35\)) than that of project farmers (10.58 ropani). The average livestock unit (LU\(^36\)) with project and non-project farmers is 2.75 and 2.45 respectively.

3.2 Women’s Daily Working Schedule

Generally, women worked for longer hours in both project and non-project areas than their men counterparts. Their involvement is found to be more or less fixed in most of the daily activities at the household level, such as house cleaning, fetching water, cooking food, cleaning dishes, and

\(^{34}\) Beneficiaries and non-beneficiary, project and non-project groups, treatment and control groups, intervened and non-intervened groups have been used interchangeably

\(^{35}\) A unit of land measurement, which is 1 ropani = 0.05 ha.

\(^{36}\) 1 LU = 0.8 cattle, 1 buffalo, 0.1 goat, 0.01 poultry, adapted from Devendra (1989)
feeding and taking care of children. Besides involvement in household chores, they also have to work on farm as farm managers and workers. The daily working schedule of women farmers in the study area is illustrated below (Fig. 1).

Women are found working longer hours than their men counterparts in both groups. The activities performed during the three shifts can vary depending on seasons; availability of family labor, geographic settings, and family status. However, the total barely reduce duration was from 12-16 a day (excluding day-rest time). The exact number of working hours varies depending on seasons, availability of family labor, geographic settings, and family status.

Figure 1: Women’s daily working schedule and regular activities in the study area

3.3 Distribution of Family Labor for Animal Production Activities

There is no distinct variation in the distribution of available family labor. Women work more in both cases. In the project area, 55 percent of males are primarily involved in grazing animals, feeding, and managing materials and shed (fixing and transferring shed at different places). Forty-nine percent of males are involved in livestock marketing (exchanging, culling, procuring,
sale) and livestock products such as milk, ghee and eggs. Female involvement is higher than that of males in milking, processing (boiling milk, making yoghurt and ghee), shed cleaning (56%), and cutting and preparing animal feed (60%).

The labor distribution among non-project farmers is somewhat different from that for project farmers with female involvement higher in grazing, feeding animals and shed management (38%); milking, processing of products, cleaning sheds (50%); and preparing animal feed (60%). Unlike females, males are heavily involved in management and marketing of livestock and products (40%). The rest are jointly done. Women thus are occupied in more time consuming activities in animal husbandry with males handling financial operations. One can thus infer that the activities are not enough to a meaningful change, especially in the gender-related roles of animal husbandry.

3.4 Women’s Involvement in Household Activities

The total daily workload of household activities related chiefly to family maintenance such as cooking and offering meals to family members, cleaning utensils, washing clothes, house sweeping, fetching water and fuelwood, raising children, and taking care of elders and the disabled. Women farmers is less (p<0.001) in project area (12.9 and 5.7 hrs respectively) than in the non-project area (14.3 and 7.2 hrs respectively). This is due to a high involvement of project women in group activities such as training, group meeting, plantation of fodder, forage cultivation, nursery management, land terracing, track construction, and other activities. The male counterparts share the work that women in the project area used to do before the project intervention. Unlike reproductive activities, both groups of women farmers were found spending an equivalent amount of time (7 hrs.) in productive activities like milking and feeding livestock; fetching fodder, forage and bedding material; working in the field; grazing animals; cleaning animal shed; marketing livestock and their products.

3.5 Wage Differentiation between Male and Female Labor

Differentiating wages for the same category of manual work between males and females is a customary practice in Nepalese society. This applies to both agricultural and non-agricultural sectors. The gender difference in wage in both areas is significant (P<0.001). However, the gap is lower in the project area. Female wage is 68 percent of male in the project area with women farmers in the non-project area receiving only 60 percent of the wages men get.

3.6 Women’s Access to Technology Transfer

Women in the project area have higher access to knowledge and skills promotion (69 %) in compared to women in non-project area (8%). In the Nepalese society, men are primarily supposed to participate in all capacity building opportunities. Opportunities for women are offered only when there are not enough men, provided guardians give permission. Human capital development activities related to “training in group management, feed and fodder production and management, husbandry practices, animal health services” concerned with sustaining the
farmers’ status quo in technical-managerial capacity has been analyzed. Besides technical training, tours, and symposiums were also organized to enhance the beneficiaries’ technical capacity. The calculated Gini Coefficient (G.C.) reveals that distribution of training quota among the female farmers is more equitable (G.C. 0.39) than for male farmers (G.C. 0.47) (Fig. 2), which seems to be a positive influence of project intervention.

Figure 2: Lorenz curve of training (no) distribution between male and female farmers

3.7 Women’s Perception on Capacity Building

Results of score ranking suggests a positive impact of project intervention on all six indicators selected to assess women’s capacity building. Among the activities, reduced working hours received the highest score due to which they can save time from additional productive work. Working hours for female farmers are found to have decreased in carrying out activities such as fetching fodder, forage and fuelwood due to their availability in the leased land. The respondents gave second rank to increased earning capacity and chances of promoting knowledge and skills. In aggregate, the leadership quality was also found upgraded as they took over various positions in groups and other activities. As a whole, the performance of female groups was found to be the best of all types of groups formed. However, the impact on increasing female participation in household decision-making processes ranks second last from the bottom.

Table 1: Women’s response about impact of project on capacity building opportunities

<table>
<thead>
<tr>
<th>Activities</th>
<th>Number of women with different perceptions (N = 15)</th>
<th>Score ranking*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Working hours reduced</td>
<td>High: 7, Medium: 8, Low: -, No change: -</td>
<td>52</td>
</tr>
</tbody>
</table>
The latent variables (such as increased knowledge and skills, leadership quality, participation in household decision-making process, earning capacity) were difficult to express on a cardinal scale since they are solely dependent on farmers’/women’s perceptions (high, medium, low, and no change). More precisely, these are the expected changes whereby farm households have a lasting effect on total farm management and productivity. Certainly, in aggregate, positive responses of the qualitative indicator variables lie in helping improve livelihoods of the beneficiary over the years.

3.8 Women's Participation in Household Decision Making Processes

Women’s participation in household decisions, such as buying and selling farm products, application of innovation, choosing farm enterprise, schooling children, participating in social functions, and sharing casual chores were taken as indicators to assess women participation. The coefficient of women’s participation in household decision-making process between the two groups is positive and significantly different (P<0.001). It implies project intervention left a positive impact on increasing women’s participation in household decision-making processes. In other words, women are being empowered in the project area in their involvement in household decision-making process. Participation was measured in terms of multinomial variables, where 1 implied if decisions were made by males, 2 if decisions were made by females, and 3 if decisions were made jointly.

4. Factors Affecting Women Empowerment

Factors (years of schooling, access to credit, number of farm animals, skill-oriented trainings, age of the household head, off farm job, participation in project activities) affecting women's empowerment have been analyzed using the ordered probit model. The variables training, off farm job, and participation in the project reveal significantly different coefficients at 1, 5 and 10 percent levels implying a unit increase in those variables increases corresponding probability of higher values of women empowerment (WOEMP). Threshold parameters, \(\mu_1\), \(\mu_2\), and \(\mu_3\), are also significant at 1 percent level implying the four categories in response are ordered.
Table 2: Estimates of the ordered probit for factors affecting women's empowerment

| Variables                        | Coefficient | \( |Z|>z\) |
|---------------------------------|-------------|------|
| Constant                        | 0.38195     | 0.4130 |
| Years of schooling              | -0.60008    | 0.7712 |
| Access to credit                | 0.40453     | 0.8591 |
| Number of farm animals          | -0.66824    | 0.9762 |
| Skill-oriented trainings        | 0.55691     | 0.0002 |
| Age of the household head       | -0.81460    | 0.3539 |
| Off-farm income                 | 0.58733     | 0.0300 |
| Participation in project        | 0.45396     | 0.0579 |
| \( \mu_1 \)                     | 0.59080     | 0.0000 |

The marginal effects of significant variables are mentioned in the following table.

Table 3: Marginal effect of independent variables used in women's empowerment

<table>
<thead>
<tr>
<th>Variables</th>
<th>Prob (Y=0)</th>
<th>Prob (Y=1)</th>
<th>Prob (Y=2)</th>
<th>Prob (Y=3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-0.1267</td>
<td>-0.257</td>
<td>0.0429</td>
<td>0.0849</td>
</tr>
<tr>
<td>Years of schooling</td>
<td>0.0199</td>
<td>0.0040</td>
<td>-0.0067</td>
<td>-0.0134</td>
</tr>
<tr>
<td>Access to credit</td>
<td>-0.0134</td>
<td>-0.0027</td>
<td>0.0045</td>
<td>0.0090</td>
</tr>
<tr>
<td>Skill-oriented training</td>
<td>-0.1847</td>
<td>-0.0374</td>
<td>0.0625</td>
<td>0.1238</td>
</tr>
<tr>
<td>Number of farm animals</td>
<td>0.0027</td>
<td>0.0005</td>
<td>-0.0009</td>
<td>-0.0018</td>
</tr>
<tr>
<td>Age of the household head</td>
<td>0.0027</td>
<td>0.0005</td>
<td>-0.0009</td>
<td>-0.0018</td>
</tr>
<tr>
<td>Off-farm income</td>
<td>0.1948</td>
<td>0.0395</td>
<td>-0.0659</td>
<td>0.1305</td>
</tr>
<tr>
<td>Participation in project</td>
<td>-0.1506</td>
<td>-0.0305</td>
<td>-0.0509</td>
<td>0.1009</td>
</tr>
</tbody>
</table>

As far as marginal effects are concerned, one unit increase in skill-oriented trainings, decreases the probability of scoring women's empowerment ‘\( y=0 \)’ by 0.18, and increases the scoring scope for ‘\( y=3 \)’ by 0.12. In the same token, one unit increase in the off-farm income, decreases the probability of scoring women's empowerment ‘\( y=0 \)’ by 0.19, and increases the scoring ‘\( y=3 \)’ by 0.13. Similarly, with a chance to participate in the project activity, the probability of scoring women's empowerment ‘\( y=0 \)’ decreases by 0.15, and increases the scoring of ‘\( y=3 \)’ by 0.10.

5. Policy Implications

The findings show that women are over-loaded with very long daily schedules and numerous farm and household operational activities, but receive less wages than men and almost no recognition. The factors that are of significant influence need to be considered to empower them. With adequate resources available, they may perform better than their male counterparts in
managing groups, implementing activities, and utilizing the resources which can assure higher farm productivity if women are empowered in agriculture-related production activities.

Women's empowerment in terms of capacity building is a need of the time to facilitate them to become efficient producers. This will both optimize farm production and minimize resource constraints, since women are recognized to be good managers. There is thus a need for strategic policies from both the public and private institutions to address the technology aspects of the resource allocation, comparative advantage and, equal opportunity for them to participate. These are the motivating factors which can enhance the competency and problem solving capacities of women farmers and other stakeholders of a community to increase farm productivity. The future programs need to relax women’s constraint on production inputs gradually so that they can avail of alternative choices for production decisions.

References


Estimation of the Agricultural Statistics of Nepal

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1. Introduction

Although Statistics Act 2015 BS, recognizes the Central Bureau of Statistics (CBS) as the sole authority in producing economic and social statistics, various managerial and other constraints hinders the agency in generating the statistics necessary for planners and policymakers in detail and in time. Therefore other Government Ministries, Departments, Central Bank and even non-government institutions like- Federation of Nepalese Chamber of Commerce and Industry, Family Planning Association of Nepal are engaged in the production of statistics. Considering the situation the Ministry of Agriculture Development (MOAD) of Nepal Government now brings out agricultural statistics for planning and policymaking in Agriculture sector to monitor the Millennium Development Goal (MDG) i.e. ‘Eradicating Extreme Poverty and Hunger’ and help in forecast Nation's Gross Domestic Product (GDP) and assess the food security situation in the country.

About 67% of total economically active population is engaged in agriculture as the main occupation. The current share of agriculture in gross domestic product is about 35% (CBS, 2013). The above figures show that Nepal is an agrarian society and most of her inhabitants are engaged in subsistent agriculture. Considering these facts; National Agricultural Policy 2004 has initiated transformation of these subsistent farmers toward commercialization to contribute in the national economy as its main priority. But the system needs some modification. The present paper is one step in that direction.

2. Situation Review

The estimation of GDP related indicators of the nation are being performed by the CBS since last 50 years. The most important part of GDP was used to be agricultural sector since then. Though the share of agriculture in GDP is decreasing year by year, two thirds of the country's economically active people are engaged in agriculture (CBS 2004).

The agriculture statistics has two major components a. basic and b. current statistics. The basic one includes information which is slowly changing in nature, for example land tenure, parcel size, area under temporary crop or permanent crop, farming practices, soil type, irrigation facilities, cropping intensity etc. The current statistics are highly affected by weather phenomenon such as temperature, rainfall, disasters. Examples are the production and yield of different crops as well as the numbers of livestock and products.
The basic agricultural statistics are collected by the CBS through decennial censuses while the current, particularly on those related to area and production of various crops and number as well as production of various livestock and others have been produced by the MOAD with the help of its departments, directorates and district offices.

In 1991, the authority of producing current agricultural statistics was given to the CBS. In the beginning, there was an understanding between the CBS and the MOAD that current agricultural statistics should be produced by both organizations for some years and then MOAD would stop and CBS would take over, but that did not happen.

Due to the large organizational structure of the MOAD: about 350 offices in the 75 districts and 10 to 20 agricultural and livestock service, sub service centers in all the districts and an extensive technical staff of more than 10,000 are now at work was easy for the MOAD to produce the current statistics rather than CBS, which has only 33 field offices with only about 500 field staff.

These and apart from other managerial, financial constraints prevented the CBS from producing current agriculture statistics. CBS is still doing some crop and livestock surveys, but the MOAD is now brings out data regularly on semiannual and annual production of cereal crops (rice, wheat, maize, millet, buckwheat, and barley), cash crops (jute, sugarcane, tobacco, tea, and coffee), pulses, horticultural crops (fruits, vegetables and potato), spice crops (cardamom, ginger, chilly, turmeric, garlic etc.), some special crops (mushroom, honeybee and silkworms), livestock (cattle, buffaloes, goat, sheep, pig, fowl and ducks) and their production (milk, meat, wool, eggs), fisheries and many other agriculture related variables at the district level. These are the only estimates currently available in the country for analyzing the food security situation and estimation of GDP as well as for planning and policymaking in agricultural and other sectors. At present thus the only source of current agriculture statistics in the country is MOAD.

3. Methodology

The methodology currently being applied by the Ministry for the production of current agriculture statistics of the nation mainly consists of the following parts.

3.1 Interview with selected farmers

A two-stage sample design is being applied for selection of farmer households. Data obtained from periodical agricultural censuses are taken as a frame for this survey. In the first stage, selection of wards is done as PSU (primary sampling units) by probability proportional to size (PPS) sampling technique. The number of PSUs ranges between at least 30 or 5 percent of the total number of wards in the district, depending upon the size of holdings (agricultural households) in the district. For the second stage sampling, all holdings of the selected wards are first listed. Five percent of these holdings among listed are selected for interview by systematic sampling technique. These selected holdings are interviewed two times a year for the estimation/adjustment of area/production of crops and number/production of various livestock.

3.2 Crop Cutting
Crop Cutting experiment for major Crops; paddy, maize, wheat, millet, potato, oilseed, lentil and other is performed by the respective agricultural service centers- sub centers of the district and closely monitored by the district, regional and central offices. Generally, 2 by 5 square meters plot is taken for this experiment but in the case of unavailability in some area (mountain region) the size is lowered. The experiment is done for irrigated and non-irrigated also for improved or local seeds used. The crop cutting experiment is done mostly for the estimation of yield rates of crops. The production is estimated by data obtained through interview with farmers and the productivity obtained by crop cutting surveys. The area of respective crops in the district is compared with the area obtained through Agriculture Census and necessary adjustment is done.

3.3 Crop situation report and effect of natural disaster

Necessary adjustment is done from the information obtained through field observation of crops and effect of natural disaster such as; flood, drought, hailstone, cold wave etc. The Ministry has set up a system of weekly monitoring and reporting on the situation of crops and livestock as well as agricultural input, diseases, weather conditions. The service centers, sub- centers report the situation weekly to the district offices reports are compiled in the district and forwarded to the Ministry. Ministry compiles all these reports and publishes them in a bi monthly bulletin. The reports on crop situations, weather, input and disaster are used to adjust the area/production, number/production of crops and livestock.

3.4 Estimation of fishery and other special crops

For estimation of fishery related statistics, captive ponds are listed and a random selection of these ponds and monthly interview with owners gives the estimation on the fishery statistics of nation. In a similar fashion applying fixed productivity (kg/ha), fish production from natural ponds, streams, and rivers is estimated.

For minor crops like mushroom, honey, chilly, turmeric etc the reporting from the district offices as well as the concerned technical directorates is taken into consideration.

4. Data Dissemination

Data are disseminated in the following three steps.

- First estimate of summer crops in the month of October /November;
- Second estimate of winter as well as all other crops May/June;
- Final data publication in the form of Statistical Yearbook in December.

5. Recommendations

The system as explained above is not working properly due to the conflicts and underway priority given to agriculture statistics. The staff could not reach given to sampled households in some places and in many others they were not allowed to collect data properly.
Considering the importance of current agriculture statistics in planning and policymaking and critical contribution in national economy; the process of producing current agriculture statistics need revision.

Many different crop modeling and seasonal forecast software like DSSAT and toolkits like CRAFTS developed by CCAFS and the remote sensing technology have been there to help of the agriculture statistics and the time is to use them for the benefit of this sector.

By and large the implementing agency is not involved in the process of indicator measurement. The MOAD and its department’s main job is to implement agricultural plans and programs to raise the living standard of farmers and modernizing the farming practice; rather than collection of statistics. But the need of timely indicators during planning and monitoring phase is very much crucial. Hence overall system of production of statistics particularly economic statistics has to be revised or authority has to be given to other organizations like CBS or should be given the priority within the MOAD system with better equipment and trained human resources.

6. Conclusions

Current agriculture statistics are very important for planning and policymaking in agriculture as well as in estimating nation’s GDP. These statistics should be reliable, valid, and accurate in terms of time and quality and there must be a system to produce these statistics in time with high quality. If the implementing agencies are given authority to measure output it can lead to biased outcomes. To overcome these problems scientific tools must be used in crop modeling and monitoring, remote sensing should be used in and authority should be given to independent agencies such as the CBS for the production of statistical data including current agricultural statistics.

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Horticulture in the Food and Nutrition System of Nepalese Economy

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Abstract

Nepal enjoys a comparative advantage in growing all major food crops including fruits, vegetables, and spices despite its food deficit and nutrition insecurity. Those who are completely dependent on agriculture are vulnerable to nutrition. Poverty and under-nutrition is also associated with geographical region, caste hierarchy, and farm size of the household. Majority of the Dalits are vulnerable to food and nutrition insecurity compared to the non-Dalits. The problem is also related with seasons of the year. The level of education of the household, family size, and the number of children below seven years also affect nutrition. Inaccessible districts are more prone to food and nutrition insecurity where market economy is rudimentary. Under-nutrition or over-nutrition prevails among the rich family and in food surplus households.

To improve nutrition security one of the key interventions considered is increased production, productivity and consumption of nutritious horticultural crops. To achieve this, improved technology transfer through demand-based horticulture extension service delivery has been envisaged where the major components include: i) improving home-gardens for year-round production and consumption of vegetables and ii) promotion of commercialization of fruits, vegetables, and spices for cash income through improved technology and marketing system.

Keywords: agro-climate, agro-biodiversity, comparative advantage, horticultural products, high value crops.

1. Background

1.1 Geophysical Settings and Opportunities

Nepal is a land-locked, rather India locked, and mountainous country located between China on the north and India other three sides. The country is almost rectangular in shape and lies between 26° 22” to 30° 27” north latitude and 80° 4” to 88° 12” east longitude, situated in a temperate region. Its length east to west is about 800 km and width north to south between 130 km to 240 km. The total land area is 147,181 square km, out of which 45,493 (30.91%) square km is under cultivation.
Topography varies from 60 m from sea level to 8848 m, the top of the world Mount Everest. The three major ecological belts (mountain, hills, and Tarai) and four distinct seasons (spring, rainy, autumn, and winter) make 12 major combinations of agro-climatic zones. Nepal is a land of extremes as she has all climatic variations within her space and is rich in agro-biodiversity. It receives monsoon rain from June to September from the Bay of Bengal, Indian Ocean, and Arabian Sea. Winter rain is received from the Mediterranean Sea. Sporadic rains are received both during autumn and spring. Specific forms of crop are cultivated at altitudes up to 4000 m. Temperature in the cultivated areas may go as low as \(-9^0\) C during winter (December/January) in the Trans-Himalayan region to as high as \(41^0\) C in Tarai during summer (May/June). Such diversity in its climate is great natural asset.

The eco-comparative advantages for horticultural crops for different seasons in Nepal could be summarised as follows:

**a. Trans-Himalayan and High Hill Region**

Trans-Himalayan and high hill region varies from 2000 to 4000 meter from sea level. Trans-Himalayan region ranges from 2800 m to 4000 m which resembles the Tibetan plateau, the dry and cool valleys. The average daily temperature during winter (December/January) fluctuates between \(-9^0\) C and \(10^0\) C, and summer temperature between 10 and \(21^0\) C, which favors specific perennial fruit crops and temperate vegetables cultivation. The high hill region between 2000 and 3000 m mostly lies in Mahabharata range. The average temperature during summer here varies from 10-15 \(0^0\) C and goes beyond \(-0^0\) C and where during winter snow fall and snow cover is common. During summer cabbage, cauliflower, carrot, radish, broad leaf-mustard, etc. can be grown and supplied to the lower hills and Tarai as off-season products for higher cash income.

**b. Mid-Hill Regions**

The mid-hills extend east to west from the width, elevation ranging 600 to 2000 meters. The summer temperature ranges between \(20^0\) and \(35^0\) C with hot and warm weather. Winter temperature ranges between \(0^0\) and \(15^0\) C and generally is cool and warm. In the mid-hills many fruit crops can grow such as citrus, guava, peach, pear, persimmon, litchi, banana, papaya, even mango and many other fruits. During different seasons of the year, seasonal and off-season fresh vegetables can be grown for both home consumption and income generation of high value. Both the trans-Himalayan / high-hills and the mid-hill areas, have a potential for export oriented farming of high value horticultural products.

**c. Tarai, Inner Tarai, and Low River Basins**

The elevation of Tarai, inner Tarai and low river basin areas varies from 60 to 600 meters with summer temperature ranging between \(30^0\) and \(41^0\) and winter average between \(15^0\) and \(20^0\) with the minimum between \(5^0\) and \(10^0\) C. Cold waves and foggy days often bring very cold weather during winter. These areas can grow tropical fruits such as mango, litchi, papaya, pineapple, and bananas both as homestead and commercial crops. During winter, vegetables such as tomato, eggplant, and sweet pepper together with temperate vegetables can be grown in the plains of
Tarai. Vegetables grown in Tarai and inner Tarai during winter are the off-season products for markets and cities of the hills and high hills.

d. Special Situation

In addition to the three major ecological zones, special pockets exist within the mid-hills and high hills. These pockets are the low lying deep valleys, and deeply cut river basins. In these zones, of hill tops lie special pockets. In such special pockets the micro-climates differ from place to place and valley to valley.

Horticultural output is the result of agro-climatic variation and is strongly affected by road accessibility. Mountain areas are suitable for commercial production of deciduous fruits and off-season temperate vegetable production during the summer rainy season. If there is road access, commercialization of such fruits and vegetables is possible. In inaccessible areas these crops can be promoted for home consumption to improve nutritional security. If harnessed properly, all major food crops grown in the world can be grown in Nepal. High value and highly nutritious horticultural crops such as various kinds of fruits, vegetables, and spices are the most favoured crops. Hence, fruits and vegetables are the specific agricultural/horticultural commodities whose promotion could significantly drive rural economic growth to contribute to food and nutritional security.

1.2 Hunger, poverty, and food security

Despite such a large agro-climatic comparative advantage, Nepal remains a food deficit and nutrition insecure country. Food security in general term is related with caloric food availability: especially cereal crops. Nutrition security is more than caloric food sufficiency. Nutrition security is to meet required protein, mineral, and vitamins for the healthy growth of the human body. In Nepal hunger, poverty, and food security are related to livelihood options available to the people. A large portion of the population who are predominantly food producers are themselves half-fed and under-nourished. Among all the Nepali households, 76.3% are engaged in agriculture with average landholding size of 0.7 and live in rural areas. Most of them are subsistence farmers. Among the subsistence farmers nearly 53% own less than 0.5 ha of land and only 4% hold 2 ha or more of land (NLSS/NPC, 2011). Those who are completely dependent on agriculture are mostly poor and lack cash income. The estimation of poverty in Nepal is based on the cost of basic needs. The overall poverty line is obtained by aggregating the food and the non-food poverty lines. The food basket of the poverty line is measured by estimating how much the poor spend to reach a minimum caloric requirement of 2,220 kcal per day. The aggregate poverty line, based on 2010/11 prices, has been estimated at Rs19, 261 per head, per year; the food poverty line is Rs11, 929, and the non-food poverty line Rs7, 332.

1.3 Distribution of poverty

Though, the country has an average poverty incidence of 25.2 %, the incidence of poverty differ as per the ecological region. The mountain and high hill region have as high as 42%, poverty. It is 15% in urban areas whereas the average incidence of poverty in the hills and the Tarai is
around 24%. Food poverty also varies with season. Seasonal poverty is lowest from October to January as it is the harvesting period and agricultural labourers get farm employment and wages. Food poverty is the highest during April-June (Reports of WFP). Thus, poverty is related to harvesting season and availability of labour wage. Poverty also increases with family size. If the number of kids below 7 years is large, food poverty increases. Poverty also differs with so called caste hierarchy. Among Dalits, 42% are poor, compared to 23%, non-Dalits. Poverty decreases with level of education. Higher education is dependent on the economic status of the household. Households headed by agri-wage workers are the poorest compared to those headed by educated professionals. Thus it is a vicious cycle.

Poverty and under-nutrition are also related to the farm size of household. Farming households with less than 0.5 ha of land are overwhelmingly poor and vulnerable to food and nutrition. Households with less than 0.5 of land holdings are completely dependent on agriculture and labor-wage. Among Nepal’s 75 districts, 41 districts are categorized as food deficit where majority of the people have agriculture as a source of livelihood. Those who are completely dependent on agriculture and agriculture wages are vulnerable to nutrition. Hunger and under-nutrition is linked with food security and food security is linked with farm size and agriculture.

2. Challenges in Improving Nutrition Security

Despite the comparative advantages of nutritious food production and consumption major challenges and drawbacks exist.

**Challenge at macro-level (sector level)**

The challenges at macro-level include:

- Absence of household level nutritious food production and consumption strategies;
- Absence of comprehensive food and nutrition policies for different ecological regions;
- Inadequate coordination among concerned ministries for food and nutrition security;
- Low investment in marketing, post-harvest management, and storage facilities for perishable products like fruits and vegetables.

**Challenges at micro-level (community level)**

The impeding factors or reasons for not growing fruits and vegetables at the community level, despite favourable climatic and seasonal opportunities include:

- Poor technical knowhow and non-availability of quality planting materials (seed, seedlings, saplings etc.) at the grass-roots level;
- Absence of appropriate production technical service delivery to the needy households;
Absence of appropriate food preparation, preservation, and consumption knowledge, skill, attitude and behavior among the target groups.

Challenges at household level

A third challenge at HHs level or among members of HHs is that of low consumption of nutritious food or uneven distribution among family members. This challenge is related to certain traditional beliefs, taboos, and misconceptions. These can be explained as:

- Wrong concept of hot and cold food among pregnant and lactating women, and among children below five years about fruits and vegetables consumption that this would create stomach disorder;
- Poor knowledge about nutritious fruits and vegetables and their preparation and use;
- Among cereal-based diets, pulses and vegetables are considered merely as items to accompany cereals and not as nutritionally important food items;
- Misconception that green leafy vegetables, legumes, and some fruits and root-vegetables are not suitable for children, lactating mothers, and elders because they are not digestible and are the causes of stomach ache and diarrhoea;
- Production of a few high value commercial products like cauliflower, cabbage, tomato, and potato for income generation, and not linked to nutrition and family consumption.

3. Food Security and Nutrition Security

3.1 Definition and dimensions of food and nutrition security

Any hungry person needs food security first and then goes for nutrition security. As defined by the 1996 World Food Summit, food security “...exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life.” (WFS, 1996)

Thus there are four dimensions of Food and Nutrition Security:

1. Physical access to nutritious food
2. Economic access to nutritious food
3. Utilization of nutritious food
4. Sustainable supply of nutritious food

The current Interim Constitution of Nepal recognizes “food sovereignty and right to food” as one fundamental right of the people. When people have access to safe food stuffs with sufficient
quantities of carbohydrates, proteins, minerals, fats, and vitamins regularly throughout the life cycle then it is nutrition security.

3.2 Basic functions of nutritious food

Nutritious food should perform three basic life functions: i) promote growth and development; ii) provide energy to work and conduct physiologic functions; and iii) protect from deficiency and diseases. To perform these functions the human body requires balanced diet.

3.3 Components of balanced diet

A balanced diet consists of safe food stuffs with sufficient quantities of carbohydrates, proteins, minerals, fats, and vitamins. For this each meal should be based on vegetable products. Cereals should constitute only half of the meal, for protein legume supplements are compulsory, fruits such as papaya, pineapple, strawberry, mango, guava, banana, temperate fruits or fruit vegetables must be included in the meal, and animal origin food should be equal to or less than 15% of the meal and should always be eaten with vegetables. Variety in foods is best because not one food meets nutrients all required. Fiber is called the body’s broom, because the insoluble fiber binds with water to escort waste out of the body. Normally, acid-alkali ratio in the blood should be 20:80. Maintenance of this ratio is essential to keep the body healthy. All toxic substances in the body are in the form of acid and to prevent accumulation of acid in the body, we must take food that is mainly alkali-genic. Vegetables like spinach, leafy salad (lettuce), cucumbers, turnips, sweet potato, radish, cabbage, cauliflower, onions are alkali-genic. All these produce alkali-genic effect ranging from 3% to 28%. The alkali-genic vegetables constitute an efficient eliminating and cleansing agency.

3.4 Management of nutrition across the life cycle

In normal developed economy and urban areas, nutrition education and provoking required amount of food consumption may work. For the well of urban people, simple nutrition information may trigger the purchase and consumption as they have affording capacity. For the urban poor increased wage /employment /cash income and mass nutrition education will trigger nutritious food consumption. Once people are aware of nutrition and have the capacity to buy it they will buy and consume it. In the urban areas such foods are available and people may have cash income and can afford and consume. But the question here is about those rural and far-flung areas where poverty is rampant and market economy is rudimentary. How to address nutrition across the life cycle in situations where poverty and food deficit prevails, road access is minimal, cash income is below average, employment opportunities at the local level also is minimal and districts are declared to be as food deficit areas.

Access to and consumption of all required foodstuffs by all people throughout the life cycle is a major issue. The answers and options may be different for different areas and different categories of people. The issue of nutritious food consumption by the poor in remote areas is of prime importance and here the responsibility lies with the state. The alternative options left with such
people and areas are to promote production and consumption of safe nutritious foods at the household level. For this, promotion of year-round home garden with various vegetables and fruits as family based nutritious food production and consumption campaign is a solution with state support.

4. Agriculture Development Strategy (ADS) and Nutrition Security

The government of Nepal (GoN), with technical support from FAO, has formulated Food and Nutrition Security Plan (FNSP) that constitutes a chapter in the Agricultural Development Strategy (ADS) for the decade 2013-23. The FNSP also complements the Multi-sector Nutrition Plan for Accelerating the Reduction of Maternal and Child Under-nutrition in Nepal (MSNP). Both the FNSP and the ADS have a vision to ensure national food and nutrition security with specific focus on the agricultural/horticultural sector as the main vehicle that can deliver it.

In FNSP there is a horticultural component in ADS. The main objectives of this component are to deliver food, nutrition, and livelihood of people through increased yields, production, and diversity of high value crops through inclusive, competitive, sustainable, and commercial horticulture and increase the availability and diversity of nutritious food at the household level throughout the country for nutritional improvement and commercialization and marketing in accessible areas for income generation. The component is expected to improve household nutrition and income through the production of fruits and vegetables throughout the year in specific eco-regions applying appropriate technology.

The ADS/FNSP Horticulture component includes more than 20 crop models for which the main interventions include: (i) improving home gardens for year-round production of vegetables, fruits, and spices; (ii) establishing village multipurpose resource nurseries (VMRN) for regular supply of planting materials (seed, seedlings, and saplings) at local level; (iii) training individual producers and cooperatives in marketing of surplus production from home gardens and commercial areas; (iv) supporting farmers in accessible areas to produce sub-tropical, temperate, and deciduous fruits and seasonal and off-season vegetables for local and distant markets; (v) enabling farmers to get organized in cooperatives to enter into production and marketing value chains for improved economy of rural farmers. The proposed commercial models of vegetables, fruits, and spices will generate local employment and make best use of the local resources.

5. Expected outputs of Horticulture component under FNSP

- Improving and establishing home gardens, especially through appropriate technologies, for year-round production of vegetables and spices;
- Establishing village multipurpose resource nurseries (VMRN) for regular supply of planting materials (seed, seedlings, and saplings) at local level;
• Supporting market development for surplus production from home garden to generate income;

• Supporting farmers in accessible areas for commercial production and marketing of fruits, vegetables, and spices;

• Enabling producer groups to be part of an organized value-chain.

6. Target Beneficiaries

Horticulture component of the FNSP intends to target some 522,500 extremely poor households or over 3 million people of all ecological regions including both accessible and non-accessible far-flung areas. Poor households are further defined as per the definition of Poverty Alleviation Fund (PAF), as households whose food grain production from their own land plus wage earnings are insufficient to meet the food requirements of the family for the whole year. These poor HHs are further sub-divided as follows:

• Households categorized as 'A' or 'Ultra - Poor' if they have food self-sufficiency of less than 3 months;

• 'B' category or 'Medium-Poor' HHs that have food sufficiency for between 3 to 6 months;

• 'C' category or 'Poor' HHs that have food self-sufficiency of between 6 and 12 months; and

• 'D' category or 'Non-Poor' HHs that have food sufficiency of more than a year, among other criteria set by the communities, though these HHs are not of concern here.

Capacity building training and production inputs have to be provided to the target household for home gardening for nutritious food production and consumption and commercial vegetable, fruit or spice production. The outputs from these activities (fruits, vegetables, and spices) are intended for domestic consumption as well as markets. In addition, 1,100 village multi-purpose nurseries shall be established to supply planting materials regularly to home gardeners.

A group approach with 10-15 members in mountains, 15-20 in the hills and 20-25 in Tarai should be the basis for technical and financial support. Various kinds of fruits, vegetables, and spices have different planting seasons in different ecological regions. Social mobilization and skill development training should be provided to the group members for implementing the appropriate crop model as per the local ecological conditions.

7. Implementation arrangements

7.1 Implementation strategy

Horticulture crops, also generally referred to as high value agricultural crops and commodities (HVACs), can make a very important contribution to income generation, poverty alleviation,
food and nutrition security, and contribute to livelihood improvement. The strategic interventions are:

- Throughout the districts identified as food deficit and nutritionally poor home gardening, and commercial production of fruits, vegetables and spices in road accessible areas with market linkage and value chain approach;

- Increased access to high quality planting materials (vegetable seeds, seedlings/fruit saplings) depending on home gardening and selected commercial model through VMRN and private sector service delivery agents;

- Improved and increased access to quality technical services through government and non-government service providers (horticultural technicians at VDC and production pocket levels);

- Improved cohesiveness and capacity of farmer groups and cooperatives in the horticulture sector for organized value chain and marketing;

- Improved access to credit support and facilitation to make effective use of it;

- Improved access to irrigation and water management and efficient water use system.

### 7.2 Implementation modality

The horticulture components would be implemented through multi-stakeholder strategy. Fruit is a long-term enterprise, and specific fruit crops are fit for a particular region (temperate fruits in high hills and trans-Himalayan region, sub-tropical fruits in mid-hills and tropical fruits in Tarai). Commercial fruit orchard requires specific geographic locations and desired economies of scale for marketing. Therefore, farmers with relatively larger holdings (>0.5 ha) should be targeted. Abandoned Bari lands, degraded forest in lease, and community forests can be used for commercialization of fruit crops. This category of beneficiaries will face a relatively higher risk bearing capacity to adopt any enterprise and will be emphasized for C and D category HHs (Section 6). Vegetables are short-term enterprise and can be adjusted to different seasons of the year in different ecological areas both for home gardening and commercialization. Home gardens will be emphasized in all ecological belts (remote high hills, mid-hills, and Tarai villages where under-nutrition is widespread).
A home garden refers to a piece of land near the house where vegetables, fruits, ornamentals, medicinal plants, beekeeping, fish farming, poultry keeping, small livestock etc (whichever possible) are produced utilizing household waste-water and using family labor for year-round consumption of nutritious foods and surplus sale in the local market. Improving nutrition from home gardening requires basic production skills, production inputs, and food preparation and consumption techniques. Based on the dietary research 280 gram vegetables including dark green leafy vegetable, legumes, yellow fruits, root-vegetables and animal products such as liver, fish, egg and other animal products like milk, meat butter etc for the healthy body.

The size of home garden depends on the number of family members. At the rate of 280 gm vegetables per day per person will require nearly 100 kg of vegetables per year per person. If the family size is six, then, 600 kg cleaned vegetables will be required per year. From one square meter of fertile land 4-6 kg vegetables can be harvested if managed properly. Generally three crops can be taken from a piece of land per year. Therefore, for harvesting 600 kg, 50 to 75 square meter land is sufficient. However, intensive cropping plan and year-round production calendar must be followed. For those not having sufficient land rooftop gardening and veranda gardening could be adopted.

7.3 Implementing agencies

The FNSP envisaged no new additional and parallel institutions to implement the envisaged activities. The coordination and implementation heavily relies on existing institutions at all levels, including central, district and VDC levels. This is aimed at strengthening existing institutions and extension system to ensure sustainability and long-term development. The lead implementing agency for FNSP is the Ministry of Agriculture Development. Collaborating Ministries are Ministry of Health, and Ministry of Education. District Food and Nutrition Security Steering Committee (DFNSSC) or existing District Agriculture Development Committee (DADC) would be the coordinating body at the district level. I/NGOs, CBOs, and cooperatives working in agricultural related activities in the district affiliated with DDC and DADO would work under the direction of DFNSSC or DADC. Home gardening should be integrated as a cross cutting component in all agricultural programs/projects. At VDC level, VDC chairperson would coordinate implementation of FNSP. Agriculture, Forestry and Environment Committee (AFEC) and Citizen Awareness Center (CAC) may play the main facilitating role for CBOs and farmers groups to implement FNSP effectively. AFEC and CAC can implement one window entry point in each VDC for all the development agencies GO, I/NGOs, CBOs, and local institutions.

7.4 Service providers at VDC and pocket levels

- For effective service delivery, Horticulture Technician has been envisaged for each VDC for technical backstopping to the farmers at grassroots level for result-oriented horticulture extension and nutrition education services.
GoN should also develop private extension service providers by giving them intensive training and licence, and supporting them through a pilot coupon system as Local Service Providers for Demand Responsive Service delivery mechanism.

The existing Agriculture Service Centers should be converted into a center of excellence for demonstrating new technology whereby horticultural producer groups may see and learn new technology. Thus the role of the Horticulture Technicians will not only play technical and advisory roles, but will be contracting, supervising, and monitoring the DRSP and coupon-contracted advisers.

VDC matching grants (currently about 15% of the total budget) could be mobilized to develop Village Multipurpose Resource Nurseries (VMRN), support the development of Home Gardens and small tools and irrigation facilities, poly houses and training to target beneficiaries for selected crop models suitable for a particular VDC.

For nutrition security, home gardening must be made a mandatory component in all agricultural projects and programs and the Government should direct and advocate NGOs and VDCs to implement year-round home gardening for nutrition security. For income generation, commercial enterprise development (market oriented production of fruits, vegetables, and spices) is recommended with basic support and skill development training.

For income generation, commercial enterprise development (market oriented production of fruits, vegetables and spices) is to be promoted with skill development training for at least one model of vegetable or spice or fruit and crop and livestock in each HH in the target districts.

8. Results Expected

More than half a million extremely poor and vulnerable households can be expected to benefit from this component in the three agro-ecological zones, namely, Tarai and plains, hills, mountain regions. The box below presents a snapshot of the overall expected results:

<table>
<thead>
<tr>
<th>Expected results from implementation of FNSP</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. More than half a million most vulnerable and food insecure households will have access to nutritious food from their home garden.</td>
</tr>
<tr>
<td>2. Per capita per year availability of fruits and vegetables will rise; fruits to 42.9 kg up from 15.9 kg an increase of 170% and vegetable from 67 kg to 102 kg, (increase of 52 %) through increased productivity and efficient marketing.</td>
</tr>
<tr>
<td>3. Poverty incidence will be reduced proportionately in ecological regions and the various urban areas to 16.9% from 25.2%.</td>
</tr>
<tr>
<td>4. Yields of fruit will reach 12 MT/ha from 10.03 MT/ha (an increase of 20%) and vegetables 18 MT/ha from 12 MT/ha (an increase of 50% ) in 10 years</td>
</tr>
<tr>
<td>5. An additional 8,000 Horticulture Technician (J.T. /J.T.A.) will be employed in VDCs.</td>
</tr>
</tbody>
</table>
6. Additional 15 million Labour Day’s employment will be generated annually in horticulture crop cultivation.
7. Fruit and vegetable import will be substituted by domestic production and export of off-season vegetable and temperate fruits and citrus will increase considerably.
8. Agro-based industries will have improved access to raw materials from increased production.

9. Conclusion

Fruits, vegetables, and spices, the three major sub-components of horticulture, are high value crops for income generation and major sources of proteins, vitamins, minerals, and calories required for human nutrition. In Nepal’s subsistence-oriented agrarian economy, promoting their production, consumption, and marketing can help to achieve the FNSP objectives in terms of immediate, medium, and long-term strategy. There is a wide range of flexibility in selection of long-term and short-term horticultural crop species by the target beneficiaries in all ecological regions. The proposed home garden and Village Multipurpose Resource Nurseries can sustain year-round home gardens for nutritious food supply at the household level. Commercial models of vegetables, fruits, and spices can generate local employment and make best use of local resources for market oriented production and income generation. All the proposed crops and technological models have been tested in various eco-zones. In order to reduce the climate change impact, long-term and short-term crops have been proposed to decrease the risk of crop failure.

The key constraints on nutrition security are inadequate technical knowledge of farmers’ in home garden and nutrition education among the HHs. Project investment will therefore concentrate on improving the knowledge, skill, attitude, and behavior about nutritious food production and consumption at the household level. Demand-responsive extension service and the establishment and improvement of home gardens with intensive year-round production pattern through group approach and cooperatives have been proposed.

Another constraint of establishing year-round home garden and commercial fruit orchard is the non-availability of seedlings, saplings, and planting material at the community and household level. This component, therefore, envisages the establishment of Village Multipurpose Resource Nursery (VMRN) at the VDC or even at three wards level. This is a fact tested and validated by Helen Keller International and CEAPRED in their home gardening program. The objective of VMRN is to develop a sustainable resource center to produce seedlings, saplings, and other planting materials and sell them to the local beneficiaries. The actual size of the should be at least 1-2 ropanis to produce the seedlings, saplings, and planting materials required and maintain mother plants of specific fruits locality suitable. Initial support can be provided by the supporting agencies (project, VDC, GoN etc) during the first two years and thereafter it may be sustained as a local service delivery and business enterprise. It should be a sustainable resource center and technical service delivery unit for the target population as a venue for practical training and modern technology demonstration center for commercial production and
demonstration. VMRN is a basic resource center proposed under FNSP for continuous supply of planting material supply and service delivery at the local level.

The overall objectives of this component are to: (1) increase knowledge and practices about the nutritional value of horticultural crops locally at the household level; (2) increase consumption of various fruits, vegetables, and other food commodities, and generate cash income; and (3) improve food consumption behaviour, education on nutritious food production, and consumption of nutritious food is very important. Increased production and consumption and surplus sale of such food crops brings nutrition security and higher rural household incomes and ensures overall food security. Nutrition education help to improve nutritional quality of the food consumed. Small-scale local food processing improves access to food products made from local ingredients, and has been successfully supported by the Poverty Alleviation Fund (PAF) and other rural finance initiatives, as also by media marketing of local food.

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Abstract

Nepal is a highly vulnerable country from climate change point of view. Agriculture is the main industry of Nepal and the changes in temperature and rainfall pattern are posing serious threat to rice production. Decrease in rice production will have significant effect on the national economy as it is the major contributor of AGDP. A study was carried out to see the effects of climate change on different aspects of rice production. Field survey was carried out in Chitwan and Kavre, two famous rice producing districts, and trend analysis of temperature and rainfall pattern as well as rice production was conducted by using quantitative techniques. Findings of this study suggests that rice production has not been affected severely by the effects of climate change so far, but adaptation measures are required to be developed and adopted to remain safe in future.

1. Introduction

Rice (Oryza sativa L.) is the most important cereal crop in the developing world and is the staple food of over the half of world's population. Rice is now grown in over 100 countries extending from 50° north to 40° south latitude and from the sea level to an altitude of 3,000 meters. Because of its long history of cultivation and selection under diverse environments, rice has acquired a broad range of adaptability and tolerance. Hence, it can be grown in a variety of water/soil regimes from waterlogged flat plains to dry hilly slopes (Lu and Chang, 1980).

In the world, the area and production of rice is concentrated in Asian countries including Nepal. Agriculture in Nepal is characterized by diversity in farming systems mainly due to the differences in agro-ecological regions as presented in Figure 1.1. Rice, maize, and wheat are the principal food crops of Nepal. Among them, rice is the most important in terms of area and production, followed by maize and wheat (MoAD, 2013). In Nepal, rice is grown in a wide range of climatic variability, from tropical plains to high mountains, such as Chhumchure, Jumla, which is 3050 masl. The total area under rice was 1.5 million ha with an average yield of 3.3 t/ha in 2011/12 (MoAD, 2012).
Rice plays a significant role in Nepalese economy. The contribution of rice was 15.64% in the agricultural gross domestic product (AGDP) (MoAD, 2013). Rice is the source of more than 50% of the total calorie intake of the people (MoF, 2009). It accounts for 51% of the total food grain production and occupies 41% of the total cropped area (MoAD, 2013). Therefore, national economic growth is heavily dependent on rice production.

![Figure 1.1 Study Districts showing hill (Kavre) and plain (Chitwan) in agro-ecological regions of Nepal](image)

Source: Department of Survey (2005).

Farmers grow rice for their livelihoods from remote villages to urban areas. Tropical plain in the south of Nepal is the major rice producing belt. In addition, this crop is also grown in the deltas and valleys, and in the slopes of hills and rivers basins of high hills.

Rice production can be increased from the expansion of cultivated area, increase in cropping intensity, and increase in yield. However, the possibility of expanding cultivated area and increasing cropping intensity is less due to increased competition over land and water resources between agricultural enterprises. Therefore, increasing yield is the only way to augment rice production and contribute towards achieving the national goal of food security. Improved technologies are the most important means for increasing rice yield. National Seed Board has released 60 domestic and registered 14 exotic rice varieties with full package of practices over the past 47 years (SQCC, 2014). The coverage of these improved varieties is 85% of the total area under rice. Although rice stands as the most important crop for national food security and supporting livelihoods, the yield of rice is lower in Nepal than other South Asian countries (Pandey, 2007). Being the highest contributor in total volume of food production, the poor yield of rice has a direct effect on the per capita edible cereal grain availability, which was 227 kg per year in 2011/12 (MoAD, 2012).

The poor rice yield is the combined effect of various factors. The use of inferior quality seeds, inadequate application of fertilizers and manures, insufficient irrigation, traditional soil and crop
management practices, unavailability of skilled labour, low or no use of farm machineries, increasing infestation of pests and diseases, changing patterns of temperature and rainfall are the major contributing factors for reducing the rice yield. Among them, rising temperature, increasing sea level, and changes in rainfall patterns as a result of climate change could lead to substantial modifications in land and water resources for rice production (Nguyen, 1998). This study focuses on the increasing concern of people on the negative consequences of climate change on rice production and food security situation.

2. Literature review

The production and productivity of rice is increasing slowly in Nepal in the past decades. Rice production increased from 3.5 million tons in 1990/91 to 5.0 million tons in 2011/12 (MoAD, 2012). In the same duration, rice yield increased merely from 2.4 to 3.3 t/ha. The yield increment is not significant in comparison to other neighbouring countries. Hence, the increase in production is contributed mainly by area expansion and less by other factors such as the use of high yielding varieties, good quality seeds, fertilizers, and irrigation. Due to irrigation difficulty, water requirement of the crop is fulfilled by rain water in majority of rice growing areas. Therefore, rice production depends largely on the distribution of monsoon rain from June to September in Nepal.

Increasing emission of green house gases (mainly CO\textsubscript{2}, CH\textsubscript{4}, and N\textsubscript{2}O) in the atmosphere is the main cause of temperature rise and the occurrence of erratic pattern of rainfall. These are causing rapid melting of glaciers and changes in seasonal weather. Shrestha et al. (1999) reported that average annual temperature of Nepal is increasing by 0.06\textdegree C. The temperature rise in the Kathmandu Valley, which is adjoining to Kavre District, is higher than the national average. Similarly, the number of dry days with day temperature of over 25\textdegree C is also increasing. Basnet (2014) reported that 1\textdegree C increase in night temperature reduces rice production by 10 percent. A trend analysis of average monthly minimum and maximum temperature of Kathmandu airport from 1980 to 2006 was carried out (see Figure 2.1 and 2.2). Significance test of both average monthly minimum and maximum temperature was done by using Students t test. The result of the test found that the trend of average monthly minimum and maximum temperature was significantly increasing ($\alpha=0.05$) at 95% level of confidence.
The study of rainfall data suggests that the total volume of annual precipitation is same, but the intensity of rainfall is increasing and the number of rainy days is decreasing every year (Malla, 2008). The average winter precipitation has increased across the country, while the summer precipitation, which is essential for rice production, has remained the same or decreased (DHM, 2008).

With the changes in temperature and rainfall pattern, disease and insect infestation has been increased in crops. Rice varieties developed in the past are less tolerant to these changes in the climatic factors. As a result, expected growth has not been achieved in rice production to meet the increasing demand of food for increased population.

In comparison to other problems water related problems are more severe in rice production. Sah and Yadav (2014) reported that 30 percent of the total cultivated area under rice is affected by drought and 13 percent of the total rice area is affected by submergence problem. To cope up with these problems, attempts have been made by the Nepal Agricultural Research Council (NARC) to develop series of rice varieties tolerant to drought and submerged condition. In this row, drought tolerant rice varieties: Tarahaara-1 and Hardinath-2 were released in 2010, and Sukkhadhan-1, Sukkhadhan-2 and Sukkhadhan-3 were released in 2011. Similarly, submergence tolerant varieties: Swarna SUB 1 and Samba Masuli SUB 1 were released in 2011 (Sah and Yadav, 2014).

Crop varieties developed in Nepal have to compete with the varieties developed in India. Due to open border, seeds of different varieties are imported to Nepal both by formal and informal means and are become popular among farmers. In such a situation, sufficient time is required to compare the performance of recently developed varieties with existing and imported varieties. Hence in-depth study on the performance of rice varieties in different situations is the need to evaluate the effects of climate change on rice production and productivity.

Considering the difference between rice yields in research field and farmers’ field, it can be said that the potential to increase rice yield is high in Nepal. The maximum grain yield of domestic rice varieties was recorded 8 t/ha in a research field at Khumaltar (Pandey, et al., 1999). However, this is far beyond the achievement in farmers' field. It was also observed that per hectare yield of rice was declining in the use of same amount of inputs year after year. On the other hand, Nepal needs to increase rice production by 1 t/ha by the end of 2020 to provide food for rapidly growing population, (Hobbs and Adhikari, 1997; Gami et al., 2001). The introduction of hybrid rice varieties in 2010 by registering them in the National Seed Board (NSB) is a major turning point in increasing rice yield at the farmers' field (SQCC, 2013). Most of these varieties have been recommended for terai region of Nepal but their production outside the recommended
domain is creating the problem of occasional crop failure. Therefore, urgent attention is required to be paid to minimize the gap between the maximum observed yield and national average yield, haphazard use of hybrid seeds, and declining yield trend in the same crop management practices.

The discussion suggested that the fluctuating rice yields and increasing vulnerability due to the effects of climate change pose a critical challenge to sustainable rice production in Nepal. Rice production could suffer even more from uneven weather patterns in the future.

3. Sources of data and method of study

The data required for this study were collected from primary and secondary sources. Primary data were collected by conducting field survey in Chitwan and Kavre districts in September 2009. The whole districts are considered the unit of analysis for this study. Both districts are located in the Central Development Region of Nepal. Chitwan district lies in the plain agro-ecological region, but Kavre district falls under the hill agro-ecological region. Farmers of both districts are renowned for commercial vegetable production, but most of them grow rice in one season. Due to their commercial orientation, farmers of both districts are trying to adopt new technologies to increase rice yield.

The collection of primary data was carried out by interviewing individual farmers, key informants (rice and vegetable traders, executive members of farmers' groups and cooperatives, cooperative officials, and concerned Government officials). Group discussion with farmers, participatory rural appraisal (PRA), and researcher’s observation were other methods employed to collect primary data.

In addition, data were also gathered from various secondary sources. The sources of secondary data are published and unpublished materials of the Government and non-Government agencies of Nepal. Climate data were collected mainly from Department of Hydrology and Meteorology (DHM).

The data collected were crosschecked at various levels and fed into spreadsheets of excel package for statistical analysis. Microsoft Excel and SPSS packages were used for coding, tabulation and calculation of collected primary as well as secondary data. The analysis of these data made easy to assess the variation and trends of temperature and rainfall, economic impacts of these changes in crop production, and problems and prospects of sustainable rice production in the plain and hilly regions of Nepal.

The data obtained from the secondary sources was reviewed to avoid duplications. Both quantitative and qualitative information was analytically presented. The data was presented in tables and graphs and analysed using statistical tools such as regression analysis, average, and percentage change, etc. Only relevant information was presented in the manuscript to make it more specific and consistent with the objectives of the study. For analytical purpose, descriptive statistical tools were used, which help to describe the basic features of the data used in a study. According to Trochim (2000), it is helpful to use simple graphics for analysis, which forms the
basis of virtually every quantitative analysis of data. Descriptive statistics help us to simplify large amounts of data in a sensible way and each descriptive statistic reduces lots of data into a simpler summary.

4. **Result and discussion**

The data received from both primary and secondary sources were analysed to derive results. The analysis was basically focused in deriving the gap between the potential and actual yield, diversification of rice varieties in study districts, impacts of climate change, especially of temperature and rainfall, on rice production, benefits of rice production to farmers, and problems and prospects of rice cultivation. The results derived from this study are compared with previous findings wherever possible.

4.1 **The yield gap**

The average yield reported by respondents was compared with the potential yield reported by the National Seed Board to find out the gap. The average yield of farmer preferred varieties was found about half of the potential of yield. Although the average yield of rice was found around half of the potential yield in farmers’ field, the resource-rich farmers have been producing 4 to 5 t/ha from the main season rice (see Table 4.1). Higher yields are realized in irrigated and well-fertilized areas, where adequate plant protection measures are adopted. The difference between the potential yield and actual yield of rice is about 1.8 to 2.2 t/ha in Chitwan and Kavre Districts. To narrow down this gap and to increase production, it is necessary to introduce appropriate crop management technologies and approaches, which include paying further attention towards integrating agricultural marketing activities and loan facilities according to farmers’ needs.

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Yield Potential (t/ha)</th>
<th>Chitwan</th>
<th>Kavre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Respondents</td>
<td>Yield_1</td>
<td>Yield_2</td>
</tr>
<tr>
<td>Sabitri</td>
<td>4.0</td>
<td>16</td>
<td>4.0</td>
</tr>
<tr>
<td>Radha-11</td>
<td>4.0</td>
<td>7</td>
<td>4.0</td>
</tr>
<tr>
<td>Khumal-4</td>
<td>6.3</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hardinath</td>
<td>5.0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Taichung-176</td>
<td>7.9</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td><strong>Total/Average</strong></td>
<td><strong>5.4</strong></td>
<td><strong>23</strong></td>
<td><strong>4.0</strong></td>
</tr>
</tbody>
</table>

Note: Rough rice based

Yield _1_: Resource rich case (where year round irrigation, on timely fertilizer and new Modern varieties are used)

Yield _2_: Resource poor case (Rice cultivation in general)

Data Source: Field Survey, 2009

4.2 **Rice variety diversification**

The study result found that different types of varieties are grown in study districts due to the variation in agro-ecological condition. Out of them, the list of dominant varieties reported by the
respondents is presented in Table 4.2. The study found that more than 80% of farmers were growing improved varieties till 2009. The average yield of these varieties in farmers' field was found about 3 t/ha, which was about half of the potential of yield rice verities, such as Khumal-4 and Khumal-9, which are suitable for mid-hill region like Kavre. The study also found that Sabitri and Radha-4 are the most popular varieties in Chitwan, whereas Khumal-4 and Hardinath are popular among farmers in Kavre. In later years, hybrid rice varieties are gaining popularity in both districts although such varieties are recommended only for terai region, like Chitwan and not for hilly region, like Kavre (SQCC, 2014).

Table 4.2: Rice variety diversification in study districts

<table>
<thead>
<tr>
<th>Varieties</th>
<th>Chitwan</th>
<th>Kavre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
</tr>
<tr>
<td>Sabitri</td>
<td>16</td>
<td>70</td>
</tr>
<tr>
<td>Radha-4</td>
<td>7</td>
<td>30</td>
</tr>
<tr>
<td>Khumal-4</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Hardinath</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Taichung-176</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Valid N</td>
<td>23</td>
<td></td>
</tr>
</tbody>
</table>

Data Source: Field Survey, 2009

From this result, it can be said that farmers are trying to escape from the effects of climate change in rice production. Farmers are interested towards short duration and high yielding varieties, such as Hardinath and hybrids, whether they are recommended for that particular domain or not.

4.3 Impacts of climatic change variability in rice production

During field survey, farmers were asked about the effects of changes in temperature and rainfall pattern on different aspects of rice production. The summary of the response of farmers is presented in Table 4.3.

Table 4.3: Response of farmers on the effects of climate change in rice production

<table>
<thead>
<tr>
<th>S.N.</th>
<th>Effect Type</th>
<th>Chitwan</th>
<th>Districts</th>
<th>Kavre</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
<td>Cumulative %</td>
<td>Frequency</td>
</tr>
<tr>
<td>1</td>
<td>Positive Effect</td>
<td>1</td>
<td>4.3</td>
<td>4.3</td>
</tr>
<tr>
<td>2</td>
<td>Early Maturity</td>
<td>2</td>
<td>8.7</td>
<td>13.0</td>
</tr>
<tr>
<td>3</td>
<td>Crop Damage</td>
<td>6</td>
<td>26.1</td>
<td>39.1</td>
</tr>
<tr>
<td>4</td>
<td>Yield Loss</td>
<td>9</td>
<td>39.1</td>
<td>78.3</td>
</tr>
<tr>
<td>5</td>
<td>Quality Loss</td>
<td>5</td>
<td>21.7</td>
<td>100.0</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>23</td>
<td>100</td>
<td>20</td>
</tr>
</tbody>
</table>

Data Source: Field Survey, 2009

In this survey, 39% farmers of Chitwan and 30% farmers of Kavre District reported that climatic change variability affected rice yield. Likewise, 22% farmers of Chitwan and 20% farmers of
Kavre experienced the loss of quality in rice due to climate change variability. Similarly, early maturity of crops was reported by 9% of the respondents in Chitwan and 25% of the respondents in Kavre. Farmers said that the early maturity of rice is also associated with the changes in temperature and rainfall pattern. As a result of the short growing season of rice, cropping patterns and cropping sequences have been changed and farmers started producing three crops a year in both districts.

In addition to the field survey, data were also gathered in these two districts through Participatory Rural Appraisal (PRA), Rapid Rural Appraisal (RRA), and interview with the key informants. Following general results were derived from the data gathered from these methods.

- Seed sowing is delayed due to late start of monsoon rain.
- Cropping patterns have been changed over the years.
- Pest and disease incidences have been increased.
- Droughts occur almost every year in the rice growing season.
- Water discharge is reduced in rivers and ultimately in tanks and canals for crops.
- Farmers' profit is reduced due to higher input prices and wages and marginal increase in output prices.

A good understanding of the processes involved in crop growth and development, as mentioned by Lebel (1998) and Lansigan et al. (2000), is required to analyze the agronomic impacts of climate change on crop production in effective and efficient manner. This understanding also allows an objective assessment of the vulnerability of production systems to exogenous climate variables. The system-based approach adopted in this research facilitates the understanding of linkages and feedback within the system components of rice based cropping system in Chitwan and Kavre districts of Nepal.

4.4 Effects of erratic pattern of rainfall and temperature rise in rice production

Nepal is highly prone to natural disasters due to the complex dynamics of hazard determinants, both natural (such as climate variability) and human induced (such as increased population). Those factors increase the vulnerability of rural livelihoods by reducing the availability of food crops. Natural factors, such as floods, landslides, debris flow, and drought are often interrelated and reduce the production of rice in Nepal. Floods are also occurred from the outburst of Glacial lakes in the Himalayan region and are triggered by global warming, hydrological, and seismic factors. Man-made factors, such as intensive deforestation, improper agriculture and irrigation practices, overgrazing on the slopes, quarrying for construction materials, and construction of infrastructure beyond the bearing capacity of hill slopes are responsible for changing the pattern
of rainfall, and ultimately for reducing rice production. The result of late monsoon and drought in 2006 and 2008 was observed in severe reduction in the production of rice (MOAD, 2012).

4.5 Production cost of rice

The simple linear regression analysis on production cost functions in Chitwan and Kavre districts found that none of the predictors were significant (Table 4.4). This indicates there are several influential factors for determining the production cost efficiency. These may be climatic factors, political instability, and farmers' own perception. However, the ANOVA of rice net revenue and year round irrigation showed that the p value is higher than 0.05% (Table 4.5). This suggests that the association between rice net revenue and year round irrigation is significant. On the other hand, the net revenue from rice crop has not been increasing smoothly despite the increase in area under year round irrigation. This indicates that although there is significant association between these two, there are other equally important factors, such as technology diffusion, market assurance, timely availability of improved seeds and other inputs, which increase or decrease the net revenue from rice crop.

Table 4.4: Simple linear regression on production cost functions in Chitwan and Kavre Districts

<table>
<thead>
<tr>
<th>Output Parameters</th>
<th>Chitwan</th>
<th>Kavre</th>
</tr>
</thead>
<tbody>
<tr>
<td>R Value</td>
<td>0.58</td>
<td>0.71</td>
</tr>
<tr>
<td>Adjusted R²</td>
<td>0.14</td>
<td>0.32</td>
</tr>
<tr>
<td>F Value</td>
<td>1.77</td>
<td>2.85</td>
</tr>
<tr>
<td>P Value</td>
<td>0.173</td>
<td>0.056</td>
</tr>
<tr>
<td>Family Size Coefficient</td>
<td>.614 (.96)</td>
<td>.589 (1.60)</td>
</tr>
<tr>
<td>Respondent Having High School Education - Coefficient</td>
<td>.009 (.02)</td>
<td>.116 (0.42)</td>
</tr>
<tr>
<td>Respondent Only Literate - Coefficient</td>
<td>-.695 (-1.74)</td>
<td>-.670 (-2.9)</td>
</tr>
<tr>
<td>Illiterate Respondent - Coefficient</td>
<td>.355 (1.06)</td>
<td>-.147 (-0.6)</td>
</tr>
<tr>
<td>Year Round Irrigation in ha - Coefficient</td>
<td>-.608 (-2.31)</td>
<td>.113 (0.56)</td>
</tr>
</tbody>
</table>

Notes: Predictors: (Constant), year round irrigation in ha, respondent only literate, illiterate, having High school education, family size.
* Figures in the parenthesis are the respective t value *Dependent Variable: production cost
Data Source: Calculated Values by Field Survey, 2009

Table 4.5: ANOVA of rice net revenue and year round irrigation

<table>
<thead>
<tr>
<th>Net Revenue</th>
<th>Sum of Squares</th>
<th>DF</th>
<th>Mean Square</th>
<th>F</th>
<th>Sig.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2367082.778</td>
<td>9</td>
<td>263009.198</td>
<td>1.027</td>
<td>.468*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>3328788.179</td>
<td>13</td>
<td>256060.629</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>5695870.957</td>
<td>22</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Data Source: Calculated Values by Field Survey, 2009

4.6 Problems, prospects, and policy implications for sustainable rice production
The field survey of this study was also focused on finding major problems faced by rice growers. The findings of the field survey are presented in Table 4.6. The table shows that the most serious problem for farmers is year round irrigation followed by lack of improved seeds, lack of availability of chemical fertilizers, inadequate technical services, and the lack of training provided by Government and non-Governmental agencies. Some of the respondents also reported that the faulty Government policy is the cause of production and market related problems of rice in Nepal.

Table 4.6 Major problems faced by farmers in Chitwan and Kavre Districts

<table>
<thead>
<tr>
<th>S.N</th>
<th>Responses</th>
<th>Chitwan</th>
<th>Districts</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Frequency</td>
<td>%</td>
</tr>
<tr>
<td>1</td>
<td>Lack of irrigation</td>
<td>11</td>
<td>48</td>
</tr>
<tr>
<td>2</td>
<td>Lack of Improved Seed</td>
<td>6</td>
<td>26</td>
</tr>
<tr>
<td>3</td>
<td>Lack of chemical fertilizer</td>
<td>3</td>
<td>13</td>
</tr>
<tr>
<td>4</td>
<td>Lack of technical suggestion/knowledge</td>
<td>2</td>
<td>9</td>
</tr>
<tr>
<td>5</td>
<td>Lack of training and others</td>
<td>1</td>
<td>4</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td>23</td>
<td>100</td>
</tr>
</tbody>
</table>

Source: Field Survey, 2009

Some prominent problems of sustainable rice production are also derived from the data received from field survey and other sources. These problems are very similar with the findings of Adhikari (2007) and Pandey and Nakagawa (2008).

- High cost of production due to low agricultural mechanization and low fertilizer use efficiency of recommended varieties.
- Poor water management practices and increasing scarcity of irrigation water.
- Erratic pattern of monsoon rain.
- Increasing soil, air and water pollution and more infestation of diseases and pests.
- Soil erosion, particularly in the hilly areas.
- Transaction of commodities and low market price of rice and other agricultural products.
- Insufficient utilization of agricultural waste.
- Shortage of manpower in rural areas due to migration of youths in cities and abroad.

An attempt was made to see the association between rice policy and technology diffusion in study areas. Because of the ordinal nature of independent variable, linear-by-linear association has been considered in this study. Likewise, the calculated p value is higher than 0.05, which indicates that the association between existing rice policy and technology diffusion is significant.
It also signifies that technology diffusion on rice farming has been affected in absence of effective rice policy. Technology diffusion can be accelerated through the implementation of comprehensive rice policy with effective monitoring mechanism (Table 4.7).

<table>
<thead>
<tr>
<th></th>
<th>Value</th>
<th>df</th>
<th>Asymp. Sig. (2-sided)</th>
<th>Exact Sig. (2-sided)</th>
<th>Exact Sig. (1-sided)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pearson Chi-Square</td>
<td>0.048a</td>
<td>1</td>
<td>0.827</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Continuity Correction</td>
<td>0.000</td>
<td>1</td>
<td>1.000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Likelihood Ratio</td>
<td>0.048</td>
<td>1</td>
<td>0.827</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fisher's Exact Test</td>
<td></td>
<td></td>
<td></td>
<td>1.000</td>
<td>0.579</td>
</tr>
<tr>
<td>Linear-by-Linear</td>
<td>0.045</td>
<td>1</td>
<td>0.831</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Association</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N of Valid Cases</td>
<td>23</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 4.7: Cross tabulated association level (Chi-Square tests) between rice policy and technology diffusion

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 5.26.

b. Computed only for a 2x2 table

Data Source: Computed based on Field Survey, 2009

This study found that variations in climatic condition have not been seriously affecting the productive capacity of rice in Nepal so far. Results also show that technological variables, such as the use of chemical fertilizers and irrigation are being adopted by farmers to minimize the adverse effect of climate change. Specifically, significant positive relationship was found between fertilizer use and rice yield in both of the study districts. However, it is suggested that appropriate technologies are required to be developed to protect crop production from negative consequences of climate change in future.

5. Summary and conclusion

Technological innovations in agriculture are not evolved only to address the effects of climatic change. Non-climatic forces, such as economic and political environment have significant impact on innovation and adaptation of new technologies.

Climate change is real and underway, so there is a need of impact identification and adoption to cope with vulnerabilities in agricultural sector. Being a least developed country, Nepal is moving towards vulnerable situation due to climate change. The observation of pattern of temperature and rainfall shows that they are changing. The maximum and minimum temperatures are rising and rainfall becomes more erratic.

The study found that the yield gap was about 1.8 to 2.2 t/ha in Chitwan and Kavre districts. This is an indicator of increasing rice production in the country by achieving the production potential. However, scientists and farmers must work jointly to further understand the crop–climate relationship and formulate viable, profitable and location-specific production technologies that will address critical issues raised by climatic variability. Improving yield, reducing costs, and
selling rice at optimum market price generate economic incentives for rice producers and motivate others to involve in this business. Ultimately, this will help in increasing food security situation of the country and improving livelihoods of large proportion of people, who are engaged in agriculture.

References


Department of Survey (2005), Government of Nepal.


The book ‘Pokari ra Pahiro’ (Ponds and Landslides in Nepali) was written by Madhukar Upadhya with two decades of experience in watershed management in midhills of Nepal published by Nepal Water Conservation Foundation with support of ICIMOD in 2012. The author presents ways of managing natural resources by reviving the lost wisdom of the traditional system of water management in the hills in order to ensure food security and adopt the problems of the extreme events caused by emerging climate change.

It provides information about how traditional dugout ponds help to check land degradation and ensure food security by reducing floods, landslides, gully formation and nutrient loss by adopting water-centric resource management in an agrarian and mountainous country like Nepal with detailed accounts of water culture, food system and political economy of soil conservation in the hills in a simple vernacular for general readers.

It has eight chapters. Chapter 1 describes the conditions of mountain villages located in diverse geographical settings while chapter 2 talks about farmers’ life in the villages in between runoff, floods and drought. Chapter 3 describes endless struggle of farmers to save the land from degradation, repair damages inflicted by monsoon and runoff to maintain their wage land productivity. The next dwells on the political economy of soil erosion and how state machinery and media avoid the urban resources to repair and rebuild damaged roads and bridges and how such damage affects life and economy of cities whereas the villages remain unattended. The next three chapters elaborate the traditional techniques of rain water management, benefits of using ponds for water management and challenges faced in promoting ponds respectively. Chapter 8 reviews the development paradigm in use to improve the living conditions of people and explains why various models and development efforts in the hills have largely failed to bring the required change. Against this backdrop, the author reflects on his experience of using ponds for water management and explains benefits of this traditional method which he claims is not only sustainable but easily implementable by farmers irrespective of their economic status. In the annex, the book presents key information about Himalayan landscape, river system, changing food systems and climate change. In sum, the book covers entire aspects of the impacts of gullies, landslides, and soil erosion on agriculture in the midhills of Nepal.

Ponds help to maintain the water tower of hills and subsequently prolong the discharge in the springs by holding the monsoon runoff, which would otherwise flow unrestricted causing erosion along its channel. The author argues with sufficient evidences that this simple and low cost technique of water management is easy to implement to bolster food security in the hills. At a time when all water management experts are focused on management of water in the streams, rivers and lakes, this book draws attention to the benefits of managing green water, i.e. the
water in the soil which helps to protect vegetation including farm crops and explains various dimensions of managing green water to improve the living condition of the poor and sustainably manage natural resources.

Managing water resource requires managing both blue and green water as well as addressing problems of wet and dry seasons together in an integrated way. The policy that focuses on management of blue water which only does not help to maintain the balance between land, water and vegetation which depends on green water. Water stays at the center of the linkages between land, water and vegetation. The current policy of managing blue water has not recognized the role of green water in maintaining blue water flow.

The author also focuses on the limitation of managing different kinds of resources. Forest-centric resource management looks after protection and productivity of vegetation only. Land-centric management is limited to farmland. But water-centric resource management helps to maintain the balance between land, water and vegetation by primarily addressing the problem of the skewed distribution of rain water which is amply available during the monsoon and too in the winter. Once the balance is maintained, it can help in improving the living conditions of farmers.

Water-centric resource management begins with management of land, because without proper land management, water can not be managed. It must begin from the ridge of the mountains where runoff volume is manageable. Managed runoff reduces chances of gully formation, landslides and eventually, flooding in the low lands. This is the traditional way of managing water in the hills.

Water demand will keep on increasing as population grows. Climate change will add further challenges to water management. Unless we begin to harvest as much rainwater as possible in the monsoon, it will be difficult to maintain the water demands during dry season. We cannot also ignore the rising costs of repair and maintenance of infrastructures damaged by floods and landslides. The nation spends billions of rupees in their repair and maintenance. The simple technique of runoff management uses ponds that would solve many of these problems at a low cost.

The book attempts to bring to the fore the fact that environmental problems associated with agriculture and food security as well as the emerging challenge of impact of climate change can be minimized with water-centric resource management. For this purpose, work must begin by conserving the farmlands in the hills. The book is helpful to students, researchers, organizations and policymakers interested in understanding the issues of land water relationship in the midhills of Nepal and other striving to improve the living condition of people in the hills. But the outreach of the book needs to be expanded by translating it into English.
Articles in the Forthcoming Issues (Ssuggestive)

Crop and Livestock Insurance Directive 2069: An Appraisal of Theory and Practice

Contribution of Common Pastureland to the Livelihood of Pastoral Community of Nepal: A Management Option

Resource Use Efficiency in Goat Production: A Case study of Lamjung District


Nepal's Agricultural Transformation: Trajectories for 2015-25

Monetary Policy for Agriculture Development: Testing Efficacy of Nepal Rastra Bank Policies

Economics of R&D and Innovation Strategies in Nepalese Agriculture Research System

The Right to Food Act

Macro-Economics of Nepalese Agriculture: Econometric and General Equilibrium Approaches

Sharing Tran-Boundary Irrigation Benefits in River Basins

Agricultural Trade in Nepal-India-China Triangle

Southern Asian Agriculture Policy Synergy and Cross-Roads

Models for Agricultural HRD with regimes of Agriculture and Forestry University