Keshav Lall Maharjan *Editor*

Communities and Livelihood Strategies in Developing Countries

Springer

Communities and Livelihood Strategies in Developing Countries

sutiyobanyumasan@yahoo.com

Keshav Lall Maharjan
Editor

Communities and Livelihood Strategies in Developing Countries

Springer

Editor
Keshav Lall Maharjan
Hiroshima University
Hiroshima, Japan

ISBN 978-4-431-54773-0 ISBN 978-4-431-54774-7 (eBook)
DOI 10.1007/978-4-431-54774-7
Springer Tokyo Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014930337

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Sustainable development has been a focal issue in development discourse, more so after the Rio Declaration with, 1992 Earth Summit and Rio Declaration to harmonize economic and environment issues, especially in the context of developing countries. Most of these countries are resource constrained and are facing the dilemma of fairly allocating their scarce resources such that the needs of the majority of their population living under poverty and hunger are met. It is not therefore uncommon to observe in these countries that a sizeable proportion of their population lives on an earning of less than US$1.25 a day (regarded as the poverty line), an amount so small to motivate individuals to engage in meaningful economic activity for a living. Economic opportunities fly in their faces and they cannot take advantage of them. They become the marginalized and the vulnerable in society and susceptible to all manner of shocks, be they global (climate change, economic crises and international contestations) or local (heavy rains, floods, droughts, volcanic eruptions, earthquakes, crop failures, pest attacks, diseases, political conflicts and other governance challenges). These shocks alter governance, production, and livelihood systems around the world. Agriculture, including crop, livestock, forestry, and fishery sub-sectors, in rural communities of developing countries is more vulnerable because of those communities' higher exposure and dependence on climate sensitive options of production and livelihood systems, and limited adaptive capacities. This, in turn, adversely affects their production and livelihood strategies, thereby making it harder to attain the millennium development goals.

Governments of developing countries do support farmers' use of modern farm inputs, "high-input high-yield agriculture", in order to improve crop yield and combat malnutrition and hunger around the world. The increased use of modern inputs imposes danger by emitting high volumes of greenhouse gases (GHGs) into the atmosphere, resulting in high temperature and uncertain rainfall patterns thereby impacting negatively on crop yields. That is, the agriculture sector seems to be heading towards a vicious cycle of becoming more vulnerable to climate variability by its current production systems. It is therefore essential to improve upon current production systems through methods that make them reduce emissions of GHGs but at the same time enhance food production to fight malnutrition and hunger around

the world more effectively. It is not out of order to adopt farming methods that enhance sustainable management of the natural resources and improve the adaptive capacity of rural communities, thereby making them more resilient to various forms of vulnerability. Well-planned and coordinated participatory local governance and development programs could make a big difference in this regard.

With these issues in mind, this book discusses composite issues of development including climate change, agricultural productivity, innovative livelihood sources, and local governance capacity and participation within the context of rural communities of lower-middle income and developing economies. These issues have become topical in international conferences of the United Nations and other development partners. The above issues are usually treated by many researchers as separate themes with weak linkages with one another. Policy proposals emanating from such academic outputs are usually disjointed and incomprehensible to policy makers, and thereby are not likely to be implemented. This book intends to account these challenges of rural development, together with some proposed actions and policy solutions, into a coherent work that is accessible to development practitioners, policymakers, researchers, students, and the public alike.

Thus, this book comprises ten chapters hinging on issues of agricultural development challenges, governance, and capacity-building issues in rural areas, innovative livelihood, and agricultural innovation adoptions by farmers spanning five countries (Bangladesh, Ghana, Indonesia, Kyrgyzstan, and Nepal). Chapter 1, as the introductory chapter of the book, briefly discusses the sustainable livelihood strategies in the context of rural communities in the developing countries to confront environmental challenges, natural disasters, political/governance changes, often treated as shocks that befall them which may or do disrupt their livelihoods. Chapter 2 explains how changing climate affects revenues of farmers both in the short- and long-run periods, with adequate incorporation of adaptive responses by farmers. This allows for clear separation between the impact of climate with and without farm-level adaptation. Chapter 3 analyzes trends of climate variables and their effects on yields of major food crops in hilly districts of Makwanpur and Ilam in Nepal based on time series data spanning 30 years. Further, this chapter also tries to recognize the local adaptation practices that could be important in promoting adaptation to climate change in the region.

It is also imperative to note that farmers respond to adverse on-farm conditions through various practices including changing the crops or varieties of those crops cultivated. By so doing, they can adopt new improved varieties of important crops grown in their communities. Replacing existing varieties is likely to reduce disease and pest attacks, as old varieties often becomes less resistant with time. In Chap. 4, the issue of adoption of improved rice seeds is discussed, with the intention of identifying the factors that strongly prompt farmers to accept improved rice varieties in the Tarai Region, the granary of Nepal.

In Chap. 5, the processes of milk production among smallholder herders in Baltagulov Village Government, Ala-Buka, Kyrgyzstan, is assessed. It is noted that managing lactation and calving seasons of livestock to match periods of forage availability is important to ensure persistent peak production of milk.

The practice of organic farming is gaining momentum in many countries. Apart from its health benefits, rational or non-use of chemical fertilizers and/or pesticides associated with organic agriculture is believed to generate higher economic benefits through premium payments. Going organic has proven to be beneficial to rural communities. Organic agriculture, involving minimal use of chemical inputs, promotes soil fertility and conservation of biodiversity, thereby ensuring stable ecosystems in the tropics. Organic production reduces the risk of yield failure, stabilizes returns, and therefore enhances food security for small farmers' families. As a livelihood strategy, it can be the main source of income for some households, while for others it can be adopted not for pecuniary reasons but just to promote the cause of organic farming in one's community through networking. With viable market access and appropriate training of farmers, it can be an important livelihood strategy for farmers. In Chap. 6, the efforts to propagate organic vegetable farming in the Kathmandu and Chitwan districts of Nepal is analyzed with the object of identifying the factors, including community trust and product certification, that determine the payment of a market premium on organic vegetables in these geographical areas. Based on this, proposals are made to ensure that the public accepts paying premium prices for organic vegetables.

Sustainable livelihoods can also be promoted through smallholder gardening, which entail growing of a variety of vegetables, food crops, and fruit trees on a small plot of land. Smallholder gardening not only contributes to household food security and incomes, but it also provides "green spaces" and biodiversity in local communities. The participation of the highly marginalized Bagdi community of Bangladesh in an action research project on kitchen gardening funded by Research Initiatives Bangladesh (RIB) is described in Chap. 7. This practice can relieve poor families of the so-called supermarket bills while, at the same time, providing nutrient supplements to households and even generating supplemental cash income that can enhance their livelihoods. Riverbed vegetable farming, under the auspices of the Forum for Rural Welfare and Agricultural Reform for Development (FORWARD) in partnership with Plan Nepal, is being piloted in the Tarai areas of Nepal as a pro-poor measure for rural communities. Farmers in the Morang and Banke districts have embraced this technology. In Chap. 8, a cost-benefit analysis of this program is carried out to ascertain the profitability of this venture vis-à-vis conventional farming and how a niche market can be created for their produce to maximize revenue from riverbed farming especially for the underprivileged, landless people utilizing these wastelands.

Disasters are part and parcel of human activity. In Chap. 9, the recovery of smallholder farmers from the ashes of the Mount Merapi volcanic eruption in 2010 is described. Dairy farmers living in this area suffered loss of their livestock to the volcanic eruption. Because the farms were organized in groups, the government found it easier to provide financial and logistic support to them. Such dairy farmers not only were able to restore their livestock numbers, but they were also able to improve the livestock value chain and establish linkages among various farmers' groups in Sleman Regency, Daerah Istimewa Yogyakarta Province, Indonesia.

The role of decentralized processes in promoting rural development cannot be overemphasized. A successful decentralized system requires sufficient local government capacity to implement newly transferred tasks. In Chap. 10, the capacity of four rural institutions, namely, village officers, neighborhood groups, village parliament, and village development committees in three villages (Serang, Kedarpan, and Sumilir) in Purbalingga District, central Java, Indonesia, is assessed. The intention of this chapter is to identify the village institutions that have human resource capacity challenges to be addressed to promote village development in the decentralized governance system.

It is hoped that this book will fulfill the needs of the people seeking to understand the issues of shocks and their relations to agriculture and rural livelihoods in general and those of communities and livelihood strategies in developing countries in particular. The empirical discussions in the local context, an addition to the dearth of such works, will be useful to those concerned about enhancing the understanding of an issue and its location-specific nature in developing countries. Readers are highly valued and will be appreciated for any comments and advice they provide to improve the contents of the book. Such comments will also furnish hints for research work in the future, which when completed will be processed for publication sooner, also by Springer.

I would like to acknowledge Zakaria Amidu Issahaku (Ph.D.) for his contributions in the editorial process, checking the manuscripts and organizing the chapters. I also would like to thank Narayan Prasad Khanal (Ph.D.) for his contributions in checking the manuscripts in the latter part of the editorial process.

Hiroshima, Japan Keshav Lall Maharjan

Contents

About the Editor

Keshav Lall Maharjan (Dr. of Agriculture in Agricultural Economics, Kyoto University, Japan) is currently a professor at the Graduate School for International Development and Cooperation, Hiroshima University, Japan, where he has been teaching, conducting research, and chairing various steering and decision-making committees since its foundation in 1994. He gives lectures for graduate students on subjects that include rural economics, South Asian studies, international development and cooperation studies. He conducts weekly seminars at the graduate school that address pertinent issues in agricultural economics, rural development, sustainable development, cultural dynamics, climate change, and rural livelihood strategies in developing countries. He also offers support for graduate students writing their master's theses and doctoral dissertations on the related topics of development

sciences, educational development, and cultural and regional studies, which include issues concerning natural resource management, food security, poverty dynamics, local governance, rural society, and community dynamics. In doing so he considers agriculture and rural regions as not only the source of cheap labor, cheap food and cheaper intermediate inputs, and subordinate to urban centers as marginal sectors and peripheral regions but also as a dignified way of life for people who are guardians of nature and are more conscious about the earth, humans, and their interaction, so as to sustain this culture and civilization for generations hereafter. Rural regions are such places that make these things happen. Hence, fieldwork to grasp the diverse realities of location-specific rural regions before generalizing the research is given importance in his research, lectures, and in educating graduate students in terms of their research, writing journal articles and dissertations. Some 25 students have received their Ph.D. from Hiroshima University under his guidance

In order to disseminate research findings, consolidate ideas and concepts, and share knowledge with other professionals, he regularly participates in local, national, and international seminars and conferences organized by academic societies, research institutions, various organizations, and like-minded individuals, including agricultural economists, ruralogists, sociologists, environmentalists, anthropologists, educationalists, policy makers, development practitioners, farmers, social activists, local leaders, and opinion shapers.

Some of his earlier books in English include *Climate Change, Agriculture and Rural Livelihoods in Developing Countries*, Tokyo: Springer Japan, 2013; *Peasantry in Nepal: A Study on Subsistence Farmers and Their Activities Pertaining to Food Security*, Hiroshima: Research Center for Regional Geography, Hiroshima University, 2003; and *Impacts of Irrigation and Drainage Schemes on Rural Economic Activities in Bangladesh,* Hiroshima: Research Center for Regional Geography, Hiroshima University, 1997. He has also contributed chapters to publications including *Climate Change: Asian Perspective*, Jaipur: Rawat Publication, 2012; *Public Policy and Local Development – opportunities and constraints*, International Geographical Union Commission on Geography and Public Policy, 2008; *Political and Social Transformation in North India and Nepal*, New Delhi: Manohar Publishers, 2007; *Small-Scale Livelihoods and Natural Resource Management in Marginal Areas of Monsoon Asia*, Dehra Dun: Bishen Singh Mahendra Pal Singh, 2006; *New Challenges Facing Asian Agriculture under Globalization.* Selangor: Malaysian Agricultural Economics Association, 2005; *Translating Development: The Case of Nepal*, New Delhi: Social Science Press, 2003; and *Sustainable Agriculture, Poverty and Food Security*, Jaipur: Rawat Publications, 2002. He contributes to various related academic journals and has more than 100 refereed journal articles to his credit. He has also produced numerous books and refereed journal articles in Japanese.

About the Author

Zakaria Amidu Issahaku is currently a senior economics officer at the Ministry of Finance and Economic Planning (MOFEP), Ghana, and a Ph.D. candidate at the Graduate School of International Development and Cooperation, Hiroshima University. He has worked with the ministry since 2001 in the Aid/Debt Management Division (ADMD) and the Real Section Division (RSD). At ADMD, he was scheduled officer for some bilateral and commercial creditors including Germany, the United States, the Netherlands, Japan, Spain, Austria, and the Fortis Bank. At RSD, he handled assigned tasks on agricultural and environmental issues.

He has published research articles on issues of climate change, agricultural productivity, and poverty related to Ghana.

Suman Lal Shrestha is currently a Ph.D. student at the Graduate School for International Development and Cooperation, Hiroshima University, Japan. He has completed a Master of Arts in International Development and Cooperation, Hiroshima University, Japan, and a Master of Environmental Science from the College of Applied Science–Nepal, Tribhuvan University, Nepal. He considers the natural environment as an integral part of life and has always been interested in rural livelihood. He is doing research on climate change and rural livelihood and has published papers such as "Climate Change Vulnerability of Farmers at the Local Level in Nepal. Cases of Makwanpur and Ilam Districts".

Narayan Prasad Khanal (Dr. of Rural Economics, Hiroshima University) is currently an assistant professor at the Graduate School for International Development and Cooperation, Hiroshima University, Japan. He supports students engaged in the Global Internship Program at this university and is engaged in community-based seed system research. He has ten years' experience in designing, implementing, and evaluating more than a dozen action research and development projects related to rural livelihoods, environmental cooperation, and sustainable development. He has published eight journal articles and ten proceedings papers at the national and international levels. Dr. Khanal has also been involved in the institutionalization of innovations generated through participatory approaches including releasing of crop varieties by combining data generated from development projects and national agricultural research organizations.

Munavar Zhumanova (Master of Arts, Agrarian Policy and Sustainable Land Management) is currently a leading specialist at the Pasture Department, Ministry of Agriculture and Melioration, Kyrgyzstan, where she has been working, and supervising activities of pasture committees in the Chuy Region of Kyrgyzstan since July 2013. Her main job experience and professional skills were gained at the Regional Department of Agrarian Development in Ala-Buka District, Zhalal-Abad Oblast, by working as a main specialist from 2005 to 2013. At the same time, she has been collaborating with the Research Institute of Livestock and Pastures as a senior researcher and with the University of Central Asia as a research fellow in natural science. Her academic and professional works include issues concerning natural resource management and conservation in animal husbandry, artificial insemination of cattle, horses in mountainous areas, the ecology and management of pastures in West Tien-Shan, ethno-botany and traditional ecological knowledge of agro-pastorals, sustainable rural development and poverty alleviation, international environmental programs and climate change issues in the agriculture sector, adaptation mechanisms, and ecosystem services for poverty alleviation (ESPA) in Kyrgyzstan. During her working activities and as a result of research achievements, she has demonstrated several innovative and demand-driven scientific research experiments and elaborated scientific works on sustainable organic agriculture development and decision-making support for farmers in the Ala-Buka District.

With the intention of sharing experience, research outcomes, and knowledge Ms. Zhumanova attends meetings, conferences, and roundtables, organized by

international and NGO institutions and organizations. As the results of her research achievements she has also produced several case studies on agrarian societies of Nepal and Japan and two academic papers under the supervision of Prof. K.L. Maharjan: "Effects of Seasonal Changes and Forage Availability on Milk Yield of Cows among Smallholder Households in Ala-Buka, Kyrgyzstan," 2013; and "Trends in Livestock Population and Composition through Derived Productivity in Kyrgyzstan: A Case Study in Ala-Buka district," 2012, which were published in the *Journal of International Development and Cooperation*, Hiroshima University.

Mrinila Singh is currently a Ph.D. student at the Graduate School for International Development and Cooperation, Hiroshima University, Japan. Before being enrolled in the Ph.D. program in 2012, she completed her Master of International Cooperation Studies from the same division. Her main research interest lies in climate change, food insecurity, and rural livelihoods. In this aspect she specializes in organic farming in the rural and semi-urban setting of a least-developed country like Nepal, where vulnerability to climate change remains high but at the same time suffers from the incidence of food insecurity. Thus, she is interested in assessing the feasibility of organic farming (socially, economically, and environmentally) as a way to combat climate change and food insecurity. So far she has published a review article, "Food Security through Organic Agriculture: A Global and National Perspective"; a book review, "Global Development of Organic Agriculture: Challenges and Prospects"; and an article, "Prospect of Farmers in Generating Additional Income through Organic Vegetable Farming: A Case Study in Kathmandu Valley and Chitwan District of Nepal". She has presented regarding her research findings at two of many conferences attended.

Dharma Prasad Pande (B.Sc. Ag. from Orissa University of Agriculture and Technology, India, 1986) started his career at the Department of Agriculture in Nepal as an agronomist and has also worked in various technical institutes that provide vocational training related to agriculture. Later, he was involved in developmental activities related to livelihood and income generation of farming communities through national-level NGOs. Currently, he is working as the senior program officer at the Forum for Rural Welfare and Agricultural Reform for Development (FORWARD Nepal). His areas of expertise are riverbed farming, leasehold vegetable farming, small livestock rearing, farm forestry, development of micro irrigation systems such as installation of treadle pumps, water harvesting in plastic lined and cemented ponds, establishment of fruit orchards in hilly and Tarai regions, cultivation of forage/ fodder, and the dairy development sector. He has also published various action research papers based on his work experience.

Introduction to Gam Bahadur Gurung

Mr. Gam Bahadur Gurung is a Master degree holder in Agricultural Science. He is the founder member of Forum for Rural Welfare and Agricultural Reform for Development (FORWARD), a national NGO working in the area of rural livelihoods in Nepal. Mr. Gurung has over 20 years' experience in research and development organizations and private agencies. He has key expertise on project design, baseline studies, impact studies, sustainable rural livelihoods, action research, value chain analysis, and business development. Mr. Gurung has published over 15 research papers, shared twenty four papers in national and international seminars. He is keen to promote pro-poor innovations for enhancing the livelihoods of resource poor communities.

Ashoke Kumar Ghosh has completed a Ph.D. in rural economics from Hiroshima University, Japan. At present he is an assistant professor of Development and Poverty Studies, Sher-e-Bangla Agricultural University (SAU), Dhaka, Bangladesh. He delivers lectures to graduate and post-graduate students on subjects that include rural sociology, state and local government, development studies, women and gender, and social development theories and practice.

His current research focuses on alternative livelihood strategies in coastal regions, ethnic and marginal communities and vulnerability, climate change and adaptation, livelihood and food security, and poverty and rural development. He has attended national and international seminars and conferences and has published a number of articles in national and international journals focused on the issues of poverty alleviation through income generation.

Mujtahidah Anggriani Ummul Muzayyanah received a Ph.D. from Hiroshima University, Japan, and now is a lecturer at Gadjah Mada University (GMU), Indonesia. She has been teaching, carrying out research, and undertaking community services. She is teaching and researching in the areas of socio-economics of animal husbandry, quantitative analysis, and consumer economics topics. She has been doing community services such as in rural livestock farming, integrated potato-goat farming, and school milk programs for elementary schools in rural areas. She has published papers in national and international journals and presented papers at meetings of Tropical Animal Production, the Asian-Australasian Association of Animal Production, the Association for Regional Agricultural and Forestry Economics, Sustainable Animal Agriculture for Developing Countries Association, and the Society of Sustainable Future for Human Security. With other colleagues in the Faculty of Animal Science, GMU, she published a book in Bahasa about mapping of potential national cattle germ plasma (*Peta Potensi Plasma Nutfah Ternak Nasional*). She has received grants for research, publication, and presentation of her research papers in both national and international journals and conferences.

Suci Paramitasari Syahlani is a lecturer at Universitas Gadjah Mada, Yogyakarta, Indonesia. She received Ph.D. from Faculty Economic and Business, Universitas Gadjah Mada in 2006. She is interested in marketing, consumer behavior and entrepreneurship and she has carrying those topics into teaching, research, consulting and community service. She is teaching in Faculty Animal Science and also Magister Management Pharmacy and Magister Management at Universitas Gadjah Mada. She has published some papers in national and international journal, books and presented some papers at international conferences. She also got some grants for her researches. Currently, she is doing social marketing research to increase milk consumption among children in rural and semi urban area.

Fransiskus Trisakti Haryadi was born on September 17th 1965, got Ph.D. degree in management and economics of agriculture and forestry from Tokyo University of Agriculture and Technology, Japan. Now he is an associate professor in Communication and Community Development Laboratory, Faculty of Animal Science Universitas Gadjah Mada (UGM), Indonesia. He is also giving some lectures and guidance for graduate students in The Extension and Development Communication Study Program at Graduated School, UGM. He is also interested in doing research related with the diffusion of agricultural innovation specifically at the small farmers' community and guide farmers on developing the dynamic of livestock farmers' group. Together with his student and other colleague in this study program, he has published paper in The Academic Research International about The influence of Parabela's Leadership Towards Society's Attitudes in Preserving Kaombo Forest in Buton Regency. He also presented paper about developing model of goat-sharing system based on farmers group to improve Etawah Crossbred in the First Asian-Australasian Dairy Goat Confrence in Malaysia. He also participated in the training of data management for rural development held by SEARCA in 1992 at the Philippines.

Yuni Suranindyah is a lecturer of Faculty of Animal Science, Universitas Gadjah Mada (UGM), Indonesia. She received Ph.D. degree from School of Agriculture at the University of Aberdeen Scotland, UK. Her interest research is dairy goat production and community development. She has published some papers in national and international journal and presented some papers at national and international conferences.

Sutiyo, Ph.D., is currently a civil servant in the district government of Purbalingga, Indonesia, where he has worked since 2003 to formulate local policies for community empowerment and rural development. Interested in issues of local government and rural development, he continuously develops academic capacity while engaging in administrative tasks as a local officer. After receiving a bachelor's in governance science from the Institute of Local Government (STPDN) Bandung in 2003 and a master's in public administration from the University of Jenderal Soedirman in 2006 in Indonesia, he continued his academic journey to the doctoral program of rural economics at the Graduate School for International Development and Cooperation, Hiroshima University, Japan. In order to share ideas and disseminate research findings, he has published several articles in academic journals and newspapers, and participated as speaker in academic conferences. He can be reached by email to sutiyobanyumasan@yahoo.com.

Chapter 1
Communities and Livelihood Strategies: An Overview

Keshav Lall Maharjan and Zakaria Amidu Issahaku

Abstract This chapter explores the livelihood strategies available to rural communities in order to counteract various environmental challenges they face. In agriculture, climate change is identified as one of the greatest threats, and farmers generally respond to adverse on-farm conditions by increased external input use, use of drought-tolerant local varieties, water harvesting, extensive planting, mixed cropping, agroforestry, opportunistic weeding, wild plant gathering and a series of other traditional farming system techniques. Farmers also diversify into on- and off-farm activities in order to maximize harvest security in uncertain and marginal environments. Sustainable livelihood strategies in rural communities should incorporate issues of human development, stable ecosystem, social equity, inter-and intra-generational fairness, and duties of care and prevention. The importance of sustainable livelihood strategies becomes evident in the cases of natural disasters such as earthquakes and volcanic eruptions. Occurrence of natural disasters diverts scarce resources, time and efforts from other sustainable development goals. Individual efforts alone may not be enough to cope with such extreme events. Even responses within and across groups of similar characteristics may not elicit the desired results. The capacity of community social institutions to deliver social services is crucial. That is, strong bonding and bridging social capital possessed by most vulnerable and poor groups might work as a very fragile safety net. Having more linking social capital (links with local government authorities) is more important for betterment of the economic environment.

K.L. Maharjan (✉)
Graduate School of International Development and Cooperation, Hiroshima University, Hiroshima, Japan
e-mail: mkeshav@hiroshima-u.ac.jp

Z.A. Issahaku
Graduate School of International Development and Cooperation, Hiroshima University, Hiroshima, Japan

Ministry of Finance and Economic Planning, Accra, Ghana
e-mail: zakh2000us@gmail.com

K.L. Maharjan (ed.), *Communities and Livelihood Strategies in Developing Countries*,
DOI 10.1007/978-4-431-54774-7_1, © Springer Japan 2014

Keywords Community social institutions • Developing countries • Local governance • Rural communities • Social capital • Sustainable livelihood strategies

1.1 Introduction

Pursuing sustainable livelihoods have become imperative in most countries, more so after the Rio Declaration. Threats of global challenges such as climate change and natural disasters exacerbate inherent socioeconomic weaknesses thereby worsening already not too impressive economic outcomes in many developing countries. Weak governance structures cannot be relied upon to deal with external shocks. The Realities of global environmental issues have caught up with many countries, and they now feature highly in programmes of governments in recent years.

Global warming, through trapping of carbon dioxide in the lower atmosphere emitted from transport, energy, agriculture and forestry sectors, threatens sustainability of the earth. As of 2004, these major sectors contributed more than 70 % of anthropogenic carbon emissions in the world (IPCC 2007). Global warming challenge has a strong tendency of disrupting agricultural production systems through its adverse effect on mean and variance of crop yields, plummeting livestock population and animal disease, and general reduced availability of fresh water to sustain agricultural production. It also manifests itself in severe droughts, land degradation and increased frequency of catastrophic storms, and thus posing a threat to the sustainability of agricultural production systems for current and future generations (Haque 2000). Extreme climatic events destroy farmlands, homes, beaches and ports in low-lying regions of the world. Shifting rainy seasons and growing intensity and variability of rainfall can also raise the likelihood of extreme events including rainstorms and dry spells which destroy or interrupt the physical development of crops (Laube et al. 2012). Food insecurity will worsen as a result of reduction of crop yields and revenues, and grassland degradation. Livestock productivity is also expected to decline in arid and semiarid regions of Asia, Africa and Latin America (FAO 2008).

The world is also challenged by the release of large volumes of toxic chemicals into the atmosphere with their attendant detrimental effect on human and plant health, and physical infrastructure. Plants which are exposed to high ambient concentration of sulfur oxide emissions become less productive or die permanently; it also increases incidence of respiratory diseases, irritation of the eyes, nose, and throat, and premature mortality; and Sulfur dioxide emissions may result in corrosion of materials used in building such as building stone and ferrous and nonferrous metals (World Bank 1998).

Depletion of the earth's ozone layer caused by the release of chlorine and bromine is also of great threat to sustenance on earth. Chlorine comes from chlorofluorocarbons (CFCs) used in the production of aerosols, refrigerants, air conditioners, foam, and solvents; and bromine originates from halon used in fire extinguishers. This depletion of the ozone layer implies that the earth will receive much higher

intensity of the sun's ultraviolet radiation that promotes skin cancers, cataracts, depresses human immune systems, creates various lung and heart diseases, depletes marine fisheries, retards the growth of trees and crops, and damages animal species (Sivasakthivel and Reddy 2011). In other words, the depletion of ozone layer caused by the production and consumption of the above products constitutes a formidable ecological threat, and our future development for that matter.

Many countries have signed on to international conventions to commit themselves to set environmental targets, as a way of growing their economies along the path of sustainability. According to The United Nations Food and Agriculture Organization (FAO), ratification of many countries to major environmental agreements on carbon emissions, species extinction and desertification has not succeeded in reversing the trend of global warming and other environmental challenges. It is therefore no wonder that continual water shortages, heat, aridity and salinity have destabilized agricultural production systems thereby creating high unmet demand for food. The advent of biofuel monoculture may increase biodiversity loss for food and for the use of future generations. With an increasing global population and overall purchasing power, more food calories are required while the availability of the necessary production factors is shrinking: forests are being converted to non-food production systems, water resources are scarcer, and climate change plus shrinking biodiversity are threatening the viability of farming communities in various locations. Today, there is no choice but to produce more with less, while deploying every effort to minimize production risks. This means that environmental sustainability in agriculture is no longer an option but an imperative (FAO 2008).

1.2 Livelihood Strategies in Rural Communities of Developing Countries

A livelihood refers to the utilization of one's capabilities or assets in a chosen activity or set of activities to earn a living. A livelihood is sustainable if it can cope with and recover from stresses or shocks without undermining the natural resource base (Scoones 1998). According to Gladwin et al. (1995), sustainable livelihood strategy should be inclusive, connected, equitable, prudent, and secure. An inclusive livelihood strategy connotes human development over time and space whereby the welfare of people and the health of ecosystem both near and far, in both the present and the future is not compromised; a connected livelihood strategy is based on the recognition that ecological, social, and economic systems are interdependent and that a nation cannot attain sustained level of welfare without social equity and stable ecosystem; Equitable livelihood strategy suggests inter-generational, intra-generational, and interspecies fairness through fair distribution of resources and property rights, both within and between generations; Prudential livelihood strategy implies duties of care and prevention technologically, scientifically, and politically; and secured livelihood strategy demands safety from chronic threats and protection from harmful disruption (Gladwin et al. 1995). In this view, development is

therefore unsustainable when an enlargement of human choice excludes, disconnects, promotes inequity, reflects imprudence or raises insecurity. Attaining sustainable livelihoods require multidisciplinary approach to draw ideas from scholars of diverse backgrounds including the social sciences to make this possible.

In agriculture, farmers generally respond to adverse on-farm conditions by either putting more land into cultivation or increasing external input use to cope with plummeting crop yields. Horizontal expansion with more acres or more head of livestock is premised on the fact that farmers will accept low price margins and maximize returns by increasing the number of units and spreading fixed costs over more units. Farmers can also engage themselves higher up the value chain beyond the farm gate into value added processing or choose to grow high value crops and livestock reserved for niche markets to earn higher profit margins.

Many farmers cope with and even prepare for climate change in order to minimize crop failure through increased use of drought-tolerant local varieties, water harvesting, extensive planting, mixed cropping, agroforestry, opportunistic weeding, wild plant gathering and a series of other traditional farming system techniques. Farmers harvest water from rooftops and divert water from natural springs into tanks. This ensures that they have a substantial amount of water stored up. In case of a drought, the stored water will be able to sustain them for about 5 months depending on the volume of the tank. The water is also used for supplementary irrigation of vegetables and crops. Some farmers dig infiltration pits along contours. Water collects in the pits during the rainy period. When the weather becomes dry, the water infiltrates underground and is used by the plants. Crops can grow up to maturity by using this conserved moisture. Farmers' experience shows that even if there are only 5 days with rain in the whole rainy season, the crops will reach maturity using conserved and harvested water in the pits. Most farmers store up food to be used in case of a drought. They may have a specific granary stocked with grains, especially those resistant to post-harvest pests.

Many farmers prefer the use of traditional grains such as millets and sorghums, which are more drought-resistant and give good yield even with very little rain, to maize. Farmers prefer specific crop varieties for drought seasons, such as an indigenous finger millet variety (*chiraufe*), as it ripens fast, and an early maturing cowpea (*Vigna unguiculata*) variety. Farmers also increase the cultivation of a diversity of crops and varieties across time and space in order to avert risks and maximize harvest security in uncertain and marginal environments, under low levels of technology and with limited environmental impact. This strategy of minimizing risk by planting several species and varieties of crops is more adaptable to weather events, climate variability and change, and resistant to adverse effects of pests and diseases. At the same time, this strategy stabilizes yields over the long term, promotes diet diversity and maximizes returns even with low levels of technology and limited resources. Such farms are endowed with nutrient-enriching plants, insect predators, pollinators, nitrogen-fixing and nitrogen-decomposing bacteria, and a variety of other organisms that perform various beneficial ecological functions. The higher biodiversity of plants, microbes, and animals inherent to these systems supports production of crops and mediates a reasonable degree of biological recycling of

nutrients. They rely on biological interdependencies that provide some level of biological pest suppression.

Alternatively, farming households can diversify into non-farm activities in order to overcome risk and seasonality associated with natural resource-based livelihoods including agriculture (Ellis 2004). Poverty and vulnerability are often associated with undue reliance on agriculture. Those farms achieving yield growth often do so due to cash resources generated from non-farm activities, rather than being the origin of growth in such activities as is the conventional wisdom. The ability to diversify is often critical to the food security of the most vulnerable rural populations. Occupational diversification possesses positive attributes for poverty and vulnerability reduction. It is partly predicated on human capital in terms of experience, skills and willingness to innovate. It generates earnings and remittances that alter the options open to the household by providing it with cash resources that can be flexibly deployed. It contributes to lessening vulnerability by ameliorating risk and reducing the adverse consumption effects of seasonality. Additionally, 'push' factors may explain occupational diversification from agriculture (Ellis and Freeman 2005). In Sub-Saharan Africa in particular, decimation of farm size at inheritance makes it difficult for young families to depend solely on farming as their main occupation. Declining crop yields resulting from declining soil fertility, and climate change and variability also tend to push farmers to seek livelihood alternatives. Further, on the policy front, premature dismantling of input subsidies and volatility of commodity prices following trade liberalization resulted in reduced returns to farming (Ellis and Freeman 2005). Many farmers had no incentive to continue farming, and the young were not equally motivated to engage their labor and other resources in agriculture.

1.3 Social Capital and Natural Disasters

Natural events like earthquakes, volcanic eruptions, tsunamis, floods, cyclones, or droughts occur within the various processes of nature. However, these events become disasters when they affect human lives and livelihoods. For developing countries, these natural disasters constitute a heavy drag on development. One major disaster can be a setback to an otherwise healthy economic growth for many years. To mitigate such natural disasters, various efforts have been made at different levels. While there has been significant focus on the pre-disaster preparedness and mitigation aspects, post-disaster reconstruction issues should not be discarded. Rehabilitation and reconstruction programs are development opportunities, and therefore their sustainability is an important issue. There are as many rehabilitation programs as there are numbers of natural disasters. Each disaster has different characteristics and disasters like earthquakes can be particularly destructive especially for lives and properties. Earthquakes affect all, including rich, middle-class and poor. When they destroy an urban area, massive re-planning of the city is required. Thus, the recovery process is a learning exercise on what is safe and sustainable for

the community. Governments and Non-Governmental Organizations (NGOs) put tremendous efforts into reducing vulnerability and enhancing sustainability in reconstruction and rehabilitation programs (Shaw et al. 2003).

Natural disasters tend to threaten the achievement of the poverty reduction targets and livelihood sustainability for that matter. Occurrence of natural disasters diverts scarce resources, time and efforts from other sustainable development goals. Ability of citizens to cope with hazards does not depend on stock of physical resources alone, but also the capacity of community social institutions to deliver social services. Communities, with properly integrated social networks to support and share resources during and after a hazard strike, are more likely to reduce the shocks and/or recover quickly from disasters. Groups that share strong ideologies and with experience of cooperating successfully, are better positioned to help each other at times of disaster than groups without such shared beliefs.

Until recently, social capital was hardly incorporated in disaster management. For instance, in Japan, earthquake disaster management has been considered as an engineering issue, and solutions were sought in a technical direction. However, the Kobe Earthquake of 1995 indicated that solutions should be multi-disciplinary, and there should be clear links between technological solutions and social solutions. Disaster Management Policy, as observed in many countries, focuses mainly on the physical part of the vulnerability and social aspects are often missing (NDRP 2001). Consequently, the reconstruction plans following major disasters focus mostly on the physical recovery and more visible impacts, and the plans often lack attention to social recovery. Analysis of community initiatives in six countries in Asia has shown that people as individuals, and communities as a whole, are the leading actors for vulnerability assessment (Shaw and Okazaki 2003). In recent years, disaster management has become closely connected to various fields such as environment, city planning, and community participation. Natural disasters not only cause life and economic losses, but in many cases create social divisions within communities as was the case of the eruption of Mt. Pinatubo, Philippines in 1991 and sometimes even creates political upheaval as in the famine triggered by flood disaster in 1974. As a recent argument of the importance of civil society for community development explains, safety of a community should be an issue which is discussed and determined by the community, since ultimately the community and/or individuals should be responsible for their own safety. As witnessed in Kobe, the government has limited capacity during times of crisis like an earthquake (Shaw and Goda 2004). It was individuals and their neighbors who saved most of the victims immediately after the earthquake. And it was the community which determined whether each member was satisfied by the rehabilitation. But in order to meet such community needs, individual effort is essential.

Disaster recovery is not only about building houses but the reconstruction of the whole community as a safer place. To mobilize each member of the community in this collective action (community development), social capital is a crucial need. Social capital, in general, refers to the trust, social norms, and networks which affect social and economic activities. A high accumulation of such capital contributes significantly to social, political and even economic performance, for better or worse.

Coleman (1988), defining it by its function, argues that obligations and expectations, information, and norms accompanied by sanctions are the three forms of social capital which are needed both inside and outside the family for a better outcome. Putnam et al. (1993) view social capital as a set of horizontal associations, including norms and civic engagements, which they measured using four indicators: newspaper readership, number of sports and cultural clubs, turnout in referenda, and incidence of preference voting. Serageldin and Grootaert (2000) stated that the Putnam type of social capital was the narrowest type of social capital, which was focusing only on horizontal networks while Coleman's concept was regarded as a broader concept as horizontal and vertical hierarchical relations are considered. They further added the formal institutions of law, government and courts as social capital, and this was regarded as the broadest category of social capital. Arrow (2000) argues that social capital cannot be labeled 'capital' because it fails to fulfill the requirement of sacrificing the present deliberately for future benefit. Many researches are inclined to the beneficial and positive aspects of social capital, neglecting its darker side (Portes and Landolt 1996; Schuller et al. 2000). The very elements of trust and networks can be a cause of exclusion of others, restriction on individuals of a particular group or community, and the fostering of socially unwanted groups such as gangs and mafia. Browning et al. (2000) argue in a study on urban crime that social networks may not only increase the bonding of neighbors in urban communities but also that of offenders or criminals. Consequently, such a community might end up with a need for more aggressive social control. Krishna (2002a) tried to analyze levels of participation in democracy using social capital in Indian rural communities and found that social capital influence is more prominent at the level of groups or small communities. He concluded that by enhancing bonding at community level, higher social capital could be obtained. Also, in his agency hypothesis, Krishna argues that social capital provides "glue," and can "gear" collective action for democracy, although capable agencies are also required. Woolcock (1998) classify social capital into three categories: Bonding social capital (ties between immediate family members, neighbors, close friends, and business associates sharing similar demographic characteristics); Bridging social capital (ties among people from different ethnic, geographical, and occupational backgrounds but with similar economic status and political influence); and Linking social capital (ties between community and those in positions of influence in formal organizations such as banks, agricultural extension offices, schools, housing authorities, or the police). He observes that poor people tend to have strong bonding social capital and some level of bridging social capital, but little linking social capital, which is the most important for betterment of the economic environment. For instance, during natural disasters or crop failure resulting from sudden climate change, bonding and bridging social capital might work as a very fragile safety net. However, to eliminate vulnerability of livelihood and make a safer and sustainable environment, linking social capital plays a critical role. Another important categorization was made by (Uphoff, 2003, Social capital and development, personal communication), who observed two categories of social capital: structural and cognitive. Included in his definition of structural social capital are roles, rules, precedents and procedures as well as a wide

variety of networks that contribute to cooperation, and specifically to mutually beneficial collective action. The cognitive social capital refers to mental processes and resulting ideas, being reinforced by culture and ideology, specifically norms, values, attitudes, and beliefs that contribute to cooperative behavior and mutually beneficial collective action.

In summarizing the epistemology of social capital, Nakagawa and Shaw (2004) define social capital as the function of mutual trust, social networks of both individuals and groups, and social norms such as obligation and willingness toward mutually beneficial collective action, which is the post disaster recovery process. This social capital will be facilitated and/or enforced by trust for community leaders and also by the political maturity of the community. Political maturity means that the community is accustomed to consensus building by having meetings and discussions among community members.

1.4 Local Governance and Sustainable Development

One of the key propositions of Section 3, Chapter 28 of Agenda 21 of 1992 Rio Earth Summit is that the process of 'good governance' which posits that sustainable development cannot be secured by government alone. A key mechanism in governance process is to involve and incorporate citizens and local organizations into the decision making process thereby enhancing political engagement and level of acceptance of difficult decisions.

With effective leadership, local governments can regulate, control, invest and promote within their legal and political remit to achieve objectives well beyond their formal duties. This can only be realized through consultation, dialogue and participation. One key element in government is institutional capacity including organizational, knowledge and leadership resources of local governments, internal patterns of behavior and ways of working, as well as the collective values, knowledge and relationships that exist within any organized group in society may be referred to as institutional capital (Healey et al. 2002). Institutions that have high levels of such capital might reasonably be expected to act effectively and efficiently and to demonstrate institutional initiative and responsibility.

Proper civic engagement ensures that representative organizations or stakeholder groups put forward the needs and concerns of the individuals whom they represent. Civic engagement in governance has a demand and supply sides. On the demand side, civil society demands from authority better governance in terms of delivery of public goods; the supply side touches on the necessity to provide social infrastructure for civil society to perform creditably.

In crafting sustainable development path, it is imperative to have strong local government. Efficient delivery of services to rural communities depends on effective organization at the community level. People are the engine of development, whose participation accelerates and sustains rural development. It is widely believed that local government has the weakest capacity to initiate and manage rural development programs. This is due to the fact that the quality and quantity of human

resources available at the local government level is seriously insufficient. Public officials lack the relevant qualifications to perform constitutionally mandated functions effectively. Investment in the training of committed public officers may help in prioritizing sustainability issues in the programs of the local government (Evans et al. 2006). In many developing countries with sufficient physical resource, human capacity to manage accelerated and sustainable development are grossly inadequate. With increased devolution of powers to the local government levels, strengthening local capacity in planning and management of accelerated and sustainable rural development has become imperative. With improved capacity, rural institutions can perform a given task effectively and efficiently with minimal dependence on external resources.

Sustainable development requires that local governments identify the following key elements of institutional capacity within the local authorities: committed officers and politicians; systematic training for sustainable development; the mainstreaming of sustainability into the working practices and 'norms' of a local authority; and the building of alliances with other local governments, in order to promote good practices and to learn from other local authorities.

Some individuals, paid officials or a team of dedicated staff, can be groomed to take a lead role in local governance. They should be people with charisma and commitment to motivate others to work hard to achieve long-term sustainability goals. These officers and politicians are prepared to prioritize long-term sustainable development goals and to take often unpopular decisions in support of this. However, in relation to both officers and politicians, there is always the possibility that the impetus for sustainable development mainstreaming and innovation will be lost, or at least slowed, when a key individual leaves the organization, or the local politics change. Funds should be earmarked for training of officers so they will be imbued with modern developments trends and innovations. Establishment of a 'horizontal' organizational structure encourages cross-departmental working and a stable environment for sustainability policy-making and the adoption of sustainable development principles for internal practices, such as eco-procurement. It is imperative to note that institutional capacity is, in the main, generated as a consequence of conscious decisions taken by local governments that have been effective in supporting and maintaining new ways of working and innovative ways of thinking. Much of this process is about institutional learning, whereby organizations do not have to continually 'reinvent the wheel.' This ensures that, as personnel change, knowledge remains locked within the structure and practices of the institution and can be built upon as circumstances change. Actions can be taken to support and nurture this process of learning.

1.5 Conclusion

This chapter discusses issues of sustainable development and how communities of developing economies strategize to confront environmental challenges that may disrupt their livelihoods. Extreme climatic events disrupt agricultural production systems and worsen food security through its adverse effects on crop yields and

livestock productivity in arid and semiarid regions of Asia, Africa and Latin America (FAO 2008). Since the Rio Declaration in 1992, many governments have signed on to environmental conventions as a sign of commitment to prioritize environmental issues in their development agenda. However, this gesture has not succeeded in reversing trends of environmental degradation and its attendant effect on ecosystems and livelihoods over the past two decades.

In agriculture, climate change is identified as one of the greatest threats, and farmers generally respond to adverse on-farm conditions by either putting more land into cultivation or increasing external input use to cope with plummeting crop yields. Many farmers are able to cope with climate change through increased use of drought-tolerant local varieties, water harvesting, extensive planting, mixed cropping, agroforestry, opportunistic weeding, wild plant gathering and a series of other traditional farming system techniques. Farmers also increase the cultivation of a diversity of crops across time and space in order to avert risks and maximize harvest security in uncertain and marginal environments. Alternatively, farming households can diversify into non-farm activities in order to overcome risk and seasonality associated with natural resource-based livelihoods including agriculture (Ellis 2004).

For livelihood strategies adopted by rural communities to be sustainable, they should incorporate issues of human development, stable ecosystem, social equity, inter-and intra-generational fairness, and duties of care and prevention (Gladwin et al. 1995). The importance of sustainable livelihood strategies becomes evident in the cases of natural disasters such as earthquakes and volcanic eruptions. Occurrence of natural disasters diverts scarce resources, time and efforts from other sustainable development goals. Individual efforts alone may not be enough to cope with such extreme events. Even responses within and across groups of similar characteristics may not elicit the desired results. The capacity of community social institutions to deliver social services is crucial. Communities, with properly integrated social networks to support and share resources during and after a hazard strike, are more likely to reduce the shocks and/or recover quickly from disasters. Groups that share strong ideologies and with experience of cooperating successfully, are better positioned to help each other in times of disaster than groups without such shared beliefs. That is, strong bonding and bridging social capital possessed by most vulnerable and poor groups might work as a very fragile safety net. Having more linking social capital (links with local government authorities) is more important for betterment of the economic environment. With increased devolution of powers to the local government levels, strengthening local capacity in planning and management of accelerated and sustainable rural development has become imperative.

References

Arrow K (2000) Observations on social capital. In: Dasgupta P, Serageldin I (eds) Social capital: a multifaceted perspective. The World Bank, Washington

Browning CR, Dietz R, Feinberg SL (2000) Negative social capital and urban crime: a negotiated coexistence perspective. URAI Working Paper 00–07. The Ohio State University, Columbus

Coleman J (1988) Social capital in the creation of human capital. Am J Sociol 94:95–120
Ellis F (2004) Occupational diversification in developing countries and implications for agricultural policy. Project Number WB0207, Programme of Advisory and Support Services to DFID (PASS). DFID, London
Ellis F, Freeman HA (eds) (2005) Rural livelihoods and poverty reduction policies. Routledge, London
Evans B, Joas M, Sundback S, Theobald K (2006) Governing local sustainability. J Environ Plan Manag 49(6):849–867
FAO (2008) Climate change adaptation and mitigation in food and agricultural sector. Technical background document from the expert consultation from 5 to 7 March, 2008, FAO, Rome. ftp://ftp.fao.org/docrep/fao/meeting/013/ai782e.pdf. Accessed 13 July 2013
Gladwin TN, Kennelly JJ, Krause T (1995) Shifting paradigms for sustainable development: implications for management theory and research. Acad Manage Rev 20(4):874–907
Haque MS (2000) Environmental discourse and sustainable development: linkages and limitations. Ethics Environ 5(1):3–21
Healey P, Cars G, Madanipour A, de Magalhaes C (2002) Transforming governance, institutionalist analysis and institutional capital. In: Cars G, Healey P, Madanipour A, de Magalhaes C (eds) Urban governance, institutional capacity and social milieu. Ashgate, Aldershot
IPCC (2007) Climate change 2007: mitigation of climate change. In: Metz B, Davidson OR, Bosch PR, Dave R, Meyer LA (eds) Contribution of Working Group III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge
Krishna A (2002) Enhancing political participation in democracies: what is the role of social capital? Comp Polit Stud 35(4):437–460
Laube W, Schraven B, Awo M (2012) Smallholder adaptation to climate change: dynamics and limits in northern Ghana. Clim Change 111:753–774
Nakagawa Y, Shaw R (2004) Social capital: a missing to disaster recovery. Int J Mass Emerg Disasters 22(1):5–34
NDRP (2001) National disaster response plan. Government of India, Delhi
Portes A, Landolt P (1996) The downside of social capital. Am Prospect 26:18–21
Putnam R, Leonardi R, Nanetti R (1993) Making democracy work. Princeton University Press, Princeton
Schuller T, Baron S, Field J (2000) Social capital: a review and critique. In: Schuller T, Baron S, Field J (eds) Social capital: critical perspectives. Oxford University Press, Oxford
Scoones I (1998) Sustainable rural livelihoods: a framework for analysis. Working paper 72, Institute of Development, University of Sussex
Serageldin I, Grootaert C (2000) Definition of social capital: an integrated view. In: Dasgupta P, Serageldin I (eds) Social capital: a multifaceted perspective. The World Bank, Washington
Shaw R, Goda K (2004) From disaster to sustainable community planning and development: the Kobe experiences. Disasters 28(4):16–40
Shaw R, Okazaki K (2003) Sustainability in grass-roots initiatives: focus on community based disaster management. UNCRD, Kobe
Shaw R, Gupta M, Sharma A (2003) Community recovery and its sustainability: lessons from Gujarat earthquake of India. Australian J Emerg Manag 18(2):28–34
Sivasakthivel T, Reddy KKSK (2011) Ozone layer depletion and its effects: a review. Int J Environ Sci Dev 2(1):30–37
Uphoff N (2003) Social capital and development. Personal Communication
Woolcock M (1998) Social capital and economic development: toward a theoretical synthesis and policy framework. Theory Soc 27(2):151–208
World Bank (1998) Pollution prevention and abatement handbook: toward cleaner production. World Bank, Washington

Chapter 2
Climate Change Impact on Revenue of Major Food Crops in Ghana: Structural Ricardian Cross-Sectional Analysis

Zakaria Amidu Issahaku and Keshav Lall Maharjan

Abstract This chapter analyzes the impact of climate change on net revenues of five major food crops in Ghanaian using Structural Ricardian method. First, a multinomial logit regression is used to evaluate crop selection among food crop farmers. The results of this regression show that warming is likely to prompt farmers to switch from the cultivation of cassava and maize to the planting of sorghum, rice and yam. Reduced rainfall is expected to decrease the selection of maize among farmers, and increase the planting of other food crops (cassava, sorghum, rice and yam). Taking into account crop selection bias, warming increases revenues of cassava and sorghum whiles additional rainfall increases sorghum revenue and decreases revenues of cassava and maize. As a long-term phenomenon, climate change is projected to reduce expected revenue from cassava and maize, but the losses in revenue can be minimized through adaptation by switching among crops. Climate change is expected to positive impact on revenues of sorghum and yam, which is expected to be maximized through crop switching (climate change adaptation). This study suggests public investment in research on high-yielding, heat-tolerant and flood-prone varieties of the above mentioned food crops in order to make crop switching a more beneficial exercise for farmers.

Keywords Climate change • Crop switching • Ghana • Major food crops • Structural Ricardian method

---

Parts of this chapter is also published in International Development and Cooperation 19(4):5–16.

Z.A. Issahaku (✉)
Graduate School of International Development and Cooperation, Hiroshima University, Hiroshima, Japan

Ministry of Finance and Economic Planning, Accra, Ghana
e-mail: zakh2000us@gmail.com

K.L. Maharjan
Graduate School of International Development and Cooperation, Hiroshima University, Hiroshima, Japan

K.L. Maharjan (ed.), *Communities and Livelihood Strategies in Developing Countries*,
DOI 10.1007/978-4-431-54774-7_2, © Springer Japan 2014

2.1 Introduction

The importance of agriculture to the economies of most developing countries cannot be overemphasized. The agricultural sector has a high share in national output while at the same time employs the largest share of the labor force in many developing countries. Agriculture contributes at least 40 % of exports, 30 % of Gross Domestic Product (GDP), up to 30 % of foreign exchange earnings and 70–80 % of employment in the Sub-Saharan region as a whole (UNECA 2005). The agricultural sector remains the primary source of employment in sub-Saharan Africa, accounting for approximately 70 % of the total employment in the late 1990s (Delgado 1995). Evidence consistently shows that agricultural growth is highly effective in reducing poverty. Gallup et al. (1998) report from a cross-country study that every 1 % increase in per capita agricultural output led to a 1.61 % increase in the incomes of the poorest 20 % of the population.

Despite visible contribution of agriculture, it suffers from perennial neglect from governments of sub-Saharan countries. Less than 10 % of annual budgeted revenue of these countries is allocated to agricultural sector (NEPAD 2009). This problem of low investment will be exacerbated by threat of global warming and its associated effects on temperature and rainfall patterns and ultimately farming. It is, thus, predicted that African countries with low adaptive capacity will suffer the unfriendly brunt of climate change since a larger proportion of their economies are in climate sensitive sectors.

In Ghana, agricultural production is largely small-holder and rain-fed (GEPA 2007). Slight change in weather and climate is expected to pose major challenges to the growth and development of Ghana's agriculture (Nankani 2009). Prompted by threats of vagaries of weather and climate, some researchers have attempted to investigate its impacts on crop production in Ghana. Based on crop simulations model, Sagoe (2006) reports that climate change will reduce yields of cassava by 3 %, 13.5 % and 53 % in 2020, 2050 and 2080 respectively, but cocoyam yield is expected to decline by 11.8 %, 29.6 % and 68 % in 2020, 2050 and 2080 respectively. Ghana Environment Protection Agency (GEPA) concludes from analysis of climate change impact on cereals that it will reduce yield of maize by 6.9 % in 2020 but that of millet will remain unaffected because it is more drought-tolerant (GEPA 2001). International Center for Tropical Agriculture (CIAT) (2011) used crop prediction model, MAXNET, to analyze impact of climate on cocoa in Ghana and La Cote d'Ivoire for 2030 and 2050. This study concludes that climate change will reduce land suitability for cocoa in the Lagunes and Sud-Comoe in Côte d'Ivoire whereas an increase in land suitability for cocoa will be observed in Kwahu Plateau in Ghana. In other areas, land suitability will remain same with the right adaptive measures. Some areas which are not currently under cocoa cultivation can become suitable for cocoa production in the future (18 Montagne in La Côte d'Ivoire).

Previous climate impact studies on crop production in Ghana tend to be more reliant on crop simulation models, describing the relationship between climate and crop growth, and ignoring farmers' actions to moderate the adverse effects of

changing climate (dumb farmers scenario). Granted that food crop farmers, the poorest segment of Ghanaian society, depend on the weather for their livelihood, this chapter uses structural Ricardian model to assess the impact of climate on major food crops based on national survey data. This approach incorporates efficient adaptive responses by farmers (Mendelsohn and Dinar 1999). Findings of this study are expected to contribute to climate impact literature and provide useful information government may need in crafting appropriate adaptation policy for Ghana.

2.2 Climate and Crop Production in Ghana

Agriculture engages about 57 % of the economically active population in Ghana (GSS 2005) and contributes about 30 % to Gross Domestic Product (GDP). About 57 % of arable land in Ghana is put into cultivation. About 90 % of farms are less than 2 ha in size, although there are some large farms and plantations, particularly for rubber, oil palm and coconut and to a lesser extent, rice, maize and pineapples. Main system of farming is traditional with hoe and cutlass being the main farming implements. There is little mechanized farming, but bullock farming is practiced in some places, especially in the Northern part of the country.

Climate in Ghana varies by agro-ecological zones. Broadly speaking, there are three ecological zones: savanna, forest and coastal zones. The savanna zone covers large parts of northern, upper east and upper west regions, and relatively smaller portions of Brong Ahafo and Volta regions. The climate, soils and other physical conditions in this zone are more suitable for cultivation of cereals like maize, sorghum, millet and rice. Other crops such as cashew, cassava, yam, potato and vegetables can be grown. In fact, apart from maize, largest production of cereals comes from this part of the country. This zone is also characterized by unimodal rainfall pattern (April–October). The forest zone covers greater part of Brong Ahafo, Volta, Ashanti, eastern and western regions. This zone is noted for the cultivation of root and tuber and cash crops including cocoa, cassava, plantain and cocoyam. This zone has bi-modal rainfall pattern (March–July and August–November) where a crop like maize is cultivated twice a year. The coastal savanna covers Greater Accra and Central regions and crops like maize and vegetables can be grown in this zone (Fig. 2.1). In all ecological zones, mean annual temperature is generally high ranging from 24 °C to 30 °C. The wettest area is the extreme southwest in the forest zone where annual rainfall is about 2,000 mm. The driest area is wedge-like strip in the coastal savanna zone where the annual rainfall is about 750 mm.

This chapter focuses on five major food crops only of cassava, maize, sorghum, rice and yam. These crops are grown for home consumption and for sale in the domestic market to meet household financial needs. These crops were chosen because they contribute significantly to GDP. These crops constitute about 80 % of food crops contribution to agricultural GDP and feature prominently in the diet of most Ghanaians (Breisinger et al. 2007). Supply of rice has a high import component. Ghana is currently self-sufficient in the production of the above-mentioned crops except rice.

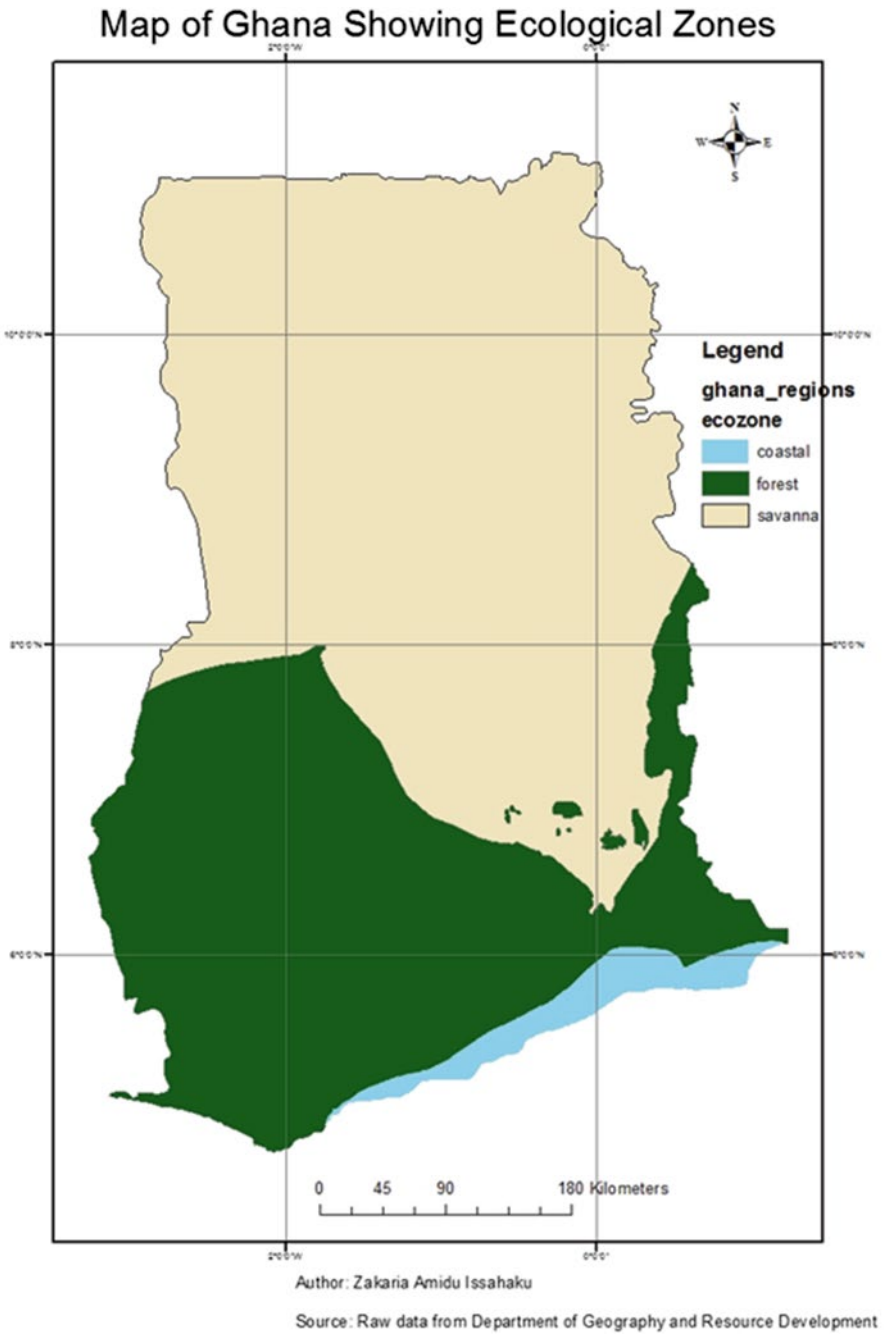


Fig. 2.1 Map of Ghana showing ecological zones

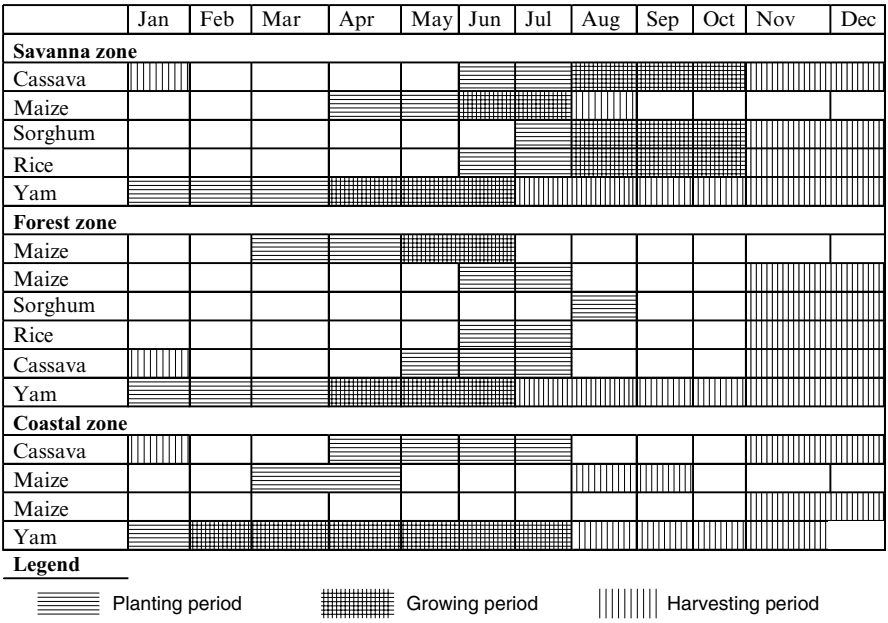


Fig. 2.2 Cropping calendar for major food crops in Ghana. *Source*: Food and Agriculture Organization (FAO) Retrieved 20 June 2012, from http://www.fao.org/agriculture/seed/cropcalendar/searchbycountry.do

2.3 Empirical Strategy

This study uses a Ricardian method to analyze the impact of climate variables on revenues from major food crops (cassava, maize, sorghum, rice and yam) in Ghana. It is so named because of the original observation of David Ricardo (1772–1823) that the value of land reflects its net productivity and, by extension, farm net revenue reflects its net productivity (Kurukulasuriya and Mendelsohn 2006). This approach captures not only the direct effect of climate on net revenue but also the adaptation response by farmers to mitigate damages associated with sub-optimal climatic conditions. This study adopts the Structural Ricardian technique whereby farmers respond to changing climate by switching crops. It is basically a micro-econometric model whereby a farmer chooses j among J crops in the first stage, and maximizes net revenues in the second stage conditional on those choices (Mendelsohn et al. 1994; Mendelsohn and Dinar 2009; Seo and Mendelsohn 2007). Based on utility theory, a crop is chosen if it gives the farmer highest net revenue as compared to other crops (Train 2003). Equations (2.1) and (2.2) are econometric specification of net revenue and crop choice equations, respectively.

$$\pi_j = X_j \beta_j + U_j \tag{2.1}$$

$$\pi_{ji} = Z_{ji} \gamma_j + \in_{ji} \tag{2.2}$$

Where, Z is a vector of explanatory variables for crop choice equation; X is a vector of independent variables for the revenue equation; π is net revenue per hectare, β and γ vector of coefficients for revenue and crop choice equations respectively; U and ∈ are the error terms for revenue and crop choice equations respectively.

Efficient and consistent estimates of Eq. (2.1) cannot be obtained if U and ∈ are correlated resulting in what is often called selectivity bias. Heckman (1979) developed a two-step procedure to correct self-selection bias in cases of binary choices while Lee (1983) and Dubin and McFadden (1984) developed the approach to apply to multiple choice. Dubin and McFadden (1984) approach to polychotomous choice, which has been enhanced by Bourguignon et al. 2007), is more appealing in that the inclusion of multiple correction terms allow us not only to attribute a selection bias in the estimation of earnings to the allocation of individuals with better or worse unobserved characteristics in farming, but also to link the selection bias to the allocation of individuals to each other alternative (Zheren 2008). That is, it allows for identification of selection bias and its source. This study employs the Dubin and McFadden (1984) approach for correction of bias in a two-stage process as five crops are involved. With the assumption that ∈ is independently and identically Gumbel distributed, logistic specification of Eq. (2.2) as in Eq. (2.3), indicating the probability (P_{ji}) that a farmer chooses a particular crop, is estimated by multinomial logistic regression at the first stage.

$$\mathrm{P}_{ji} = \frac{\exp\left(Z\gamma\right)}{\sum_{\mathrm{k}=1}^{\mathrm{k}} \exp\left(Z\gamma\right)} \tag{2.3}$$

At the second stage, Eq. (2.1) is estimated by including as additional explanatory variables the selection bias correction terms (calculated from the first stage) other than the chosen crop in each crop revenue regression (Dubin and McFadden 1984). Equation (2.4) below is the selection bias corrected (conditional) revenue regression based on Eq. (2.1):

$$\ln \pi_{\mathrm{j}} = \mathrm{X}_{\mathrm{j}}\varphi_{\mathrm{j}} + \sigma \sum_{\mathrm{i}\neq\mathrm{j}}^{\mathrm{J}} \mathrm{r}_{\mathrm{i}} \left(\frac{\mathrm{P}_{\mathrm{i}\ln P_{\mathrm{i}}}}{1-\mathrm{P}_{\mathrm{i}}} + \ln P_{\mathrm{j}} \right) + \mathrm{w}_{\mathrm{j}} \tag{2.4}$$

$\ln \pi_j$ is the logarithm of net revenue per hectare; the second term on the right-hand side is the selection bias correction term; $\mathrm{X_j}$ is a vector of independent variables that including climate variables; φ_{j} is a vector of parameters; and $\mathrm{w_j}$ is the error term. $\ln \mathrm{P_i}$ is logarithm of crop probability (P_i); σ stands for standard deviation of error term in Eq. (2.2); and $\mathrm{r_i}$ is the correlation coefficient between error terms in Eqs. (2.1) and (2.2). The above correction of selection bias provides fairly good estimation of net crop revenue even if crop choices are completely independent of each other (Bourguignon et al. 2007).

Having estimated Eqs. (2.3) and (2.4), expected revenue of a typical farm V is calculated as the sum of the probabilities of each crop choice times the conditional net revenue of that crop choice as follows:

$$\mathrm{V} = \sum_{j=1}^{J} P_j\left(Z_{ji}\right)\pi_j\left(Z_{ji}\right) \tag{2.5}$$

Expected net revenue denotes long term average farm net revenue. Marginal effect of climate on expected net revenue comes from two sources: effect on the probability of crop choice and effect on conditional net revenue per hectare. To analyze the marginal impact of climate on expected net revenue, Eq. (2.5) is differentiated with respect to climate variables to obtain Eq. (2.6).

$$\frac{\partial V}{Z_c} = \frac{\partial P_j}{\partial Z_c}\cdot\pi_j + \frac{\partial \pi_j}{\partial Z_c}\cdot P_j. \tag{2.6}$$

Marginal effect of climate variables on probability of crop selection, $\partial P_j/Z_c$, is estimated by differentiating Eq. (2.5) as in Eq. (2.7).

$$\frac{\partial P_j}{\partial Z_c} = P_j\left[\gamma_j - \sum_{k=1}^{J} P_k\gamma_k\right] \tag{2.7}$$

The marginal effect of climate variables on conditional net revenue, $\partial\pi_j/Z_c$, can also be estimated by differentiating Eq. (2.4) as shown in Eq. (2.8).

$$\frac{\delta\pi_j}{\delta z_c} = \varphi_j \tag{2.8}$$

The above approach assumes profit maximization behavior subject to exogenous production conditions, no change in technology, no change in input and output prices and no carbon fertilization (Mendelsohn and Dinar 1999). More importantly, there is no full cost accounting in adapting to changing climate by switching crops. The cost of switching to new crops such as seeds and new equipment paid by farmers are correctly captured as adaptation cost. However, cost of crop failures resulting from trials of new crops and costs associated with retiring capital equipment is not captured (Kurukulasuriya and Mendelsohn 2006).

The approach was first applied in the United States and later used in other countries to predict the damages from changes in climate (Mendelsohn et al. 1994; Sanghi et al. 1998; Mendelsohn and Neumann 1999; Mendelsohn et al. 2001). Ricardian method was used to examine impact of climate change on cropland based on a survey of more than 9,000 farmers in 11 African countries including Ghana and the results show that net revenues fall with drying and warming (Kurukulasuriya and Mendelsohn 2006). Seo and Mendelsohn (2008) developed a Structural Ricardian model to analyze impact of climate on choice of farm type and farm revenue.

Results indicate that warming and drying prompts farmers to switch from crop-only or livestock-only or rain-fed farms to mixed farming or irrigated crops. Warming and drying also reduce incomes from crop-only or livestock-only or rain-fed farms whereas incomes from mixed farms and irrigated farms increase. Seo and Mendelsohn (2007) also used structural Ricardian model to assess climate impact on African livestock choices and number. The results indicate that warming enable farmers to switch from beef cattle to more heat-tolerant goats and sheep. Drying prompts farmers to switch from cattle and sheep to goats and chickens.

In general, studies using the Ricardian approaches point to the slight beneficial effects of warming and drying to U.S. and other countries in temperate zones but likely harmful effects to tropical and semi-tropical countries where most developing countries including Ghana are located.

2.4 Data and Summary Statistics

This study uses data mostly from the fifth round of the Ghana Living Standards Survey (GLSS V) conducted by Ghana Statistical Service (GSS) in 2005/2006. All non-climate variables used in this study are extracted from GLSS V. Data on climate variables were obtained from Ghana Meteorological Agency (GMET) covering ten weather stations (Wa, Navrongo, Tamale, Sunyani, Kumasi, Koforidua, Ho, Saltpond, Accra and Takoradi) across the length and breadth of the country. The climate data covers 50 years (1961–2010). Climate normal variables (temperature and rainfall) are constructed to synchronize crop-specific growing periods of all selected crops. The climate data is, then, matched with the farming households in the GLSS V.

Net revenue per hectare is calculated as the difference between gross crop revenue (sales of processed and unprocessed produce, in-kind receipts and the value of home consumed produce) and crop expenses (fertilizer, pesticide, seedlings, hired labor, irrigation and processing cost) divided by the number of hectares of farmland. The vector of independent variables X consists of climate variables and non-climate variables. The climate variables are monthly mean temperature (temperature) and monthly mean rainfall (rainfall) during growing season for respective crops. The non-climatic independent variables include household size, age, gender and years of education of the household head and farm size. The independent variables for the crop choice equation, Z, include all explanatory variables for the revenue equation in X above and the selling price of the crops in question (cassava, maize, sorghum, rice and yam).

The summary statistics of model variables is presented in Table 2.1. Net revenue per hectare is higher among the tuber crops (cassava and yam) as against the cereals. The unit price of crops ranges from 14 pesewas for yam to 42 pesewas for rice. That is, among the five food crops, rice attracts the highest output price. All growing areas have high temperature of about 26 °C. Levels of rainfall range from about 11 cm for rice to 160 cm for maize. A typical farmer who grows any of these crops is likely to be a male aged 46 years with at least a year of formal education, five household members and a farm size of about 2 ha.

Table 2.1 Description and summary statistics of model variables

Variables	Description	Cassava	Maize	Sorghum	Rice	Yam
Net revenue per hectare (GHS)	Gross crop revenue minus costs of inputs	306.40 (489.42)	200.97 (386.28)	166.25 (312.79)	135.06 (292.42)	327.62 (429.62)
Temperature (°C)	Monthly mean temperature (°C) for 1961–2010 in effective growing seasons	25.4875 (0.3717)	25.9912 (0.3689)	26.8790 (0.4362)	26.5583 (0.8245)	27.7326 (1.2230)
Rainfall (cm)	Monthly mean rainfall (cm) for 1961–2010 in the effective growing seasons	11.1582 (3.3234)	16.1399 (2.8539)	16.3079 (0.3332)	15.1723 (2.1574)	14.1799 (2.3635)
Household size	Number of individuals living in a household	4.4981 (2.6621)	5.2177 (3.2068)	5.9215 (2.8457)	5.9762 (3.3382)	5.8404 (3.5137)
Age of household head	Age in years of the head of household	48.2102 (14.8061)	45.0842 (14.9315)	48.2987 (14.9838)	46.5397 (14.7679)	47.5019 (15.7328)
Gender of household head	Dummy variable (0 = male; 1 = female)	0.3002 (0.4585)	0.1669 (0.3730)	0.1089 (0.3119)	0.1032 (0.3054)	0.1288 (0.3354)
Education of household head	Schooling years of household head	4.1547 (4.8565)	3.2112 (4.7925)	0.7823 (2.84956)	1.1984 (3.3443)	1.8096 (3.8363)
Farm size (ha)	Farm size in hectares (ha)	1.6428 (3.7547)	2.5761 (8.8999)	1.8091 (1.8371)	3.7735 (10.7838)	2.9981 (6.1471)
Crop price (GHS)	Price per kilogram of crop in 2005 (GHS)	0.3774 (0.2928)	0.3364 (0.8148)	0.3130 (0.2070)	0.4245 (0.5771)	0.1394 (0.0940)
N		1,299	1,378	395	126	520

Source: Calculated from 2005 Ghana Living Standard Survey and Ghana Meteorological Agency data
Notes: °C = Degree Celsius; GHS = Ghana Cedis; cm = centimeter; 1US$ = 0.92 GHS; figures in parenthesis are standard deviations model variables

2.5 Results and Discussion

In this section, a trend analysis of climate variables is first carried out, and then followed by an estimation of an econometric model for farmers' cropping decisions under profit maximizing conditions. This model is estimated in a two stage process. At the first stage, Eq. (2.3) is estimated using multinomial logit method. At the second stage, Eq. (2.4) is estimated using Ordinary Least Squares (OLS) method. Crop price is included as an additional explanatory variable in crop choice equation but not in the revenue equation to ensure model identification. In the ensuing sections, climate trends and the results of the two equations are presented and discussed.

2.5.1 Trend Analysis of Climate Variables

Climate variables in this study are mean monthly temperature and rainfall for growing seasons of the five food crops considered under this study. Figures 2.3, 2.4, 2.5, 2.6, and 2.7 show the trends of temperature and rainfall for cassava, maize, sorghum, rice and yam, respectively. Temperature during growing seasons for all crops over the period 1961–2010 is on an increasing trend. The rate of temperature increase is about 0.02 °C for all crops. With the exception of sorghum, rainfall amounts tend to be decreasing for all other crops over the period. Monthly average rainfall during maize growing season has the highest rate of decline of 0.21 cm. Rainfall declines at the rate of 0.140 cm and 0.104 cm for yam and rice, respectively. The least rate of rainfall decline is 0.013 cm during the growing season for cassava. Rainfall, however, increases at a rate of 0.061 cm during the sorghum cropping season.

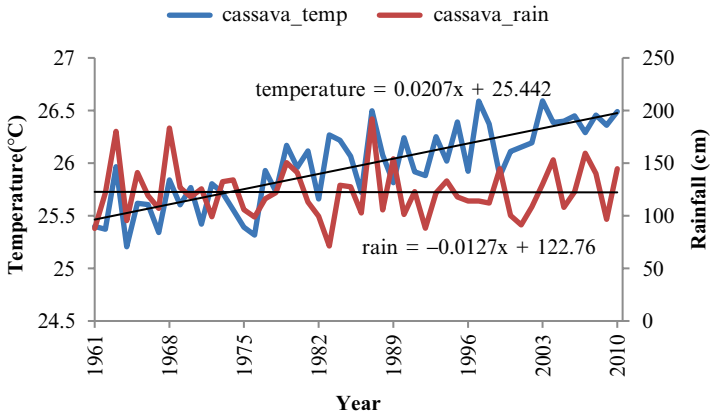


Fig. 2.3 Trends of cassava growing season temperature and rainfall

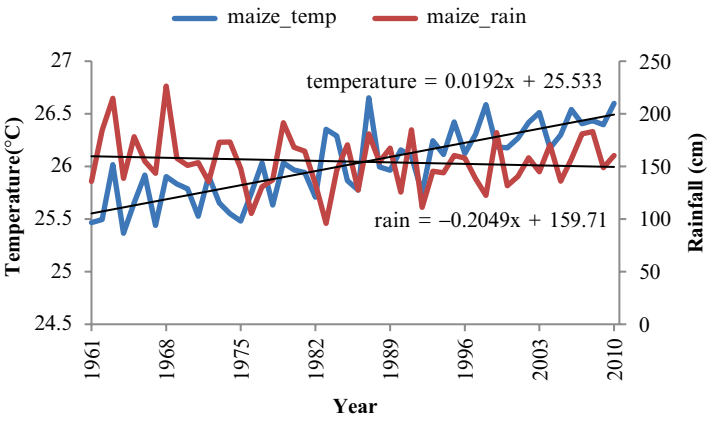


Fig. 2.4 Trends of maize growing season temperature and rainfall

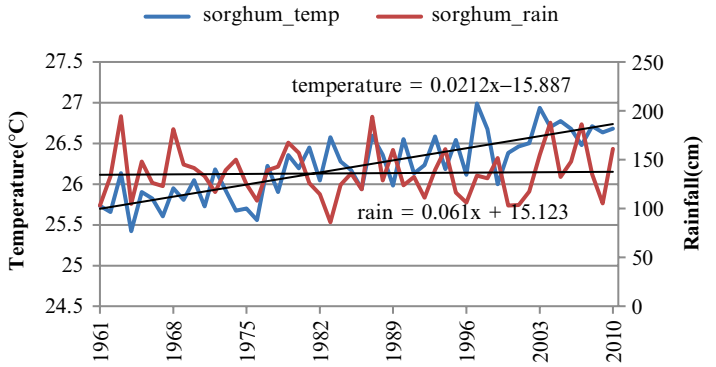


Fig. 2.5 Trends of sorghum growing season temperature and rainfall

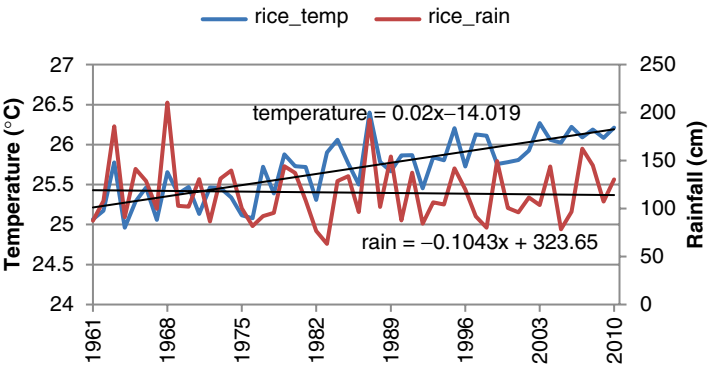


Fig. 2.6 Trends of rice growing season temperature and rainfall

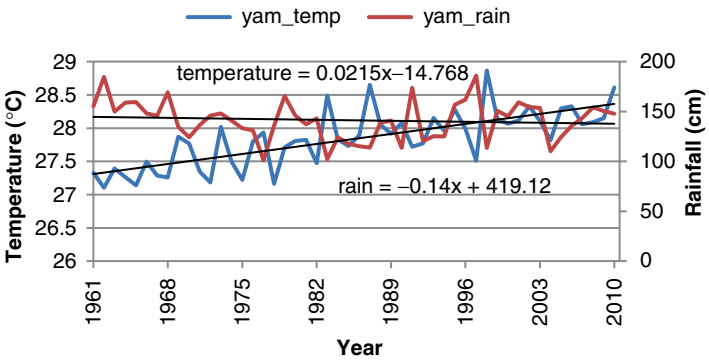


Fig. 2.7 Trends of yam growing season temperature and rainfall

2.5.2 Impact of Climate Variables on Crop Choices

This section assesses the impact of climate on farmers' probability of selecting crops using a multinomial crop choice regression. The dependent variable is crop choice variable, indicating five major food crops grown in Ghana (cassava, maize, sorghum, rice and yam). Mean monthly temperature and rainfall for growing seasons of selected crops are the main variables of interest. The other variables which are controlled for in this model are household size, age, gender and education of household head, farm size and output price variables for the selected crops.

Table 2.2 presents the regression results of the multinomial logit model. There are 3,718 observed plots in the regression. The coefficients on household size are significantly positive for all crops. This implies that cassava, sorghum, rice and yam are often chosen in larger households whereas the omitted choice, maize is selected in smaller families. The coefficients on age of heads household head have significant positive effect on cassava and yam but not on other crops, meaning that older household heads are more likely to select cassava and yam. Coefficients on female household head and education of household head are significantly positive for cassava, and negative for sorghum and rice. This implies that cassava is often chosen by female educated farmers while sorghum and rice are often grown by less educated male households. Coefficients on log of farm size are negative for cassava and positive for rice and yam, indicating that small scale farmers are more likely to select cassava while large scale farmers often grow rice and yam. Output prices tend to have positive effect on the probability of selecting cassava and rice, but negative effect on yam selection. That is, price per kilogram of yam reduces the likelihood of selecting yam. This may be due to the fact that higher prices are often as a result of higher input prices or production costs thereby negatively affecting crop selection.

Climate variables have statistically significant effect on the probability of selecting crops. The coefficients on temperature are negative for cassava but positive for sorghum, rice and yam. This means that higher temperature decreases the probability of selecting cassava but increases the selection of sorghum, rice and yam.

Table 2.2 Multinomial logit crop choice regressions in Ghana

Variables	Cassava	Sorghum	Rice	Yam
Constant term	43.0054***	−167.9339***	−137.7486***	−180.8193***
	(3.6262)	(8.6774)	(9.1929)	(8.9667)
Temperature (°C)	−1.2411***	6.6336***	5.6329***	7.3093***
	(0.1448)	(0.3409)	(0.3598)	(0.3491)
Rainfall (cm)	−0.8973***	−0.5069***	−0.7972***	−0.7665***
	(0.0438)	(0.0401)	(0.0537)	(0.0478)
Household size	0.0485**	0.0764***	0.0750**	0.0543*
	(0.0216)	(0.0254)	(0.0333)	(0.0311)
Age of household head	0.0200***	0.0074 (0.0051)	−0.0014	0.0161***
	(0.0038)		(0.0070)	(0.0059)
Female household head	0.3091**	−0.6420***	−0.6281*	0.2037072
	(0.1379)	(0.2457)	(0.3363)	0.2449763
Education of household head	0.0270**	−0.1601***	−0.1615***	0.0192364
	(0.0117)	(0.0244)	(0.0315)	0.0211688
Log of farm size	−0.1193**	0.0187499	0.3525494***	0.2155416**
	(0.0543)	0.0784363	0.1034992	0.0930771
Output price	0.1489*	−0.8334**	0.0814	−9.9929***
	(0.0802)	(0.3761)	(0.0966)	(0.7047)

Source: Authors' calculations

Notes: ***means significant at 1 %, **means significant at 5 % and *means significant at 10 %; number of observations = 3,718; LR chi2 (32) = 5,375.93***, Pseudo $R^2 = 0.5303$ and Log likelihood = −2,380.7675; This model correctly predicts 89.30 % for cassava, 80.84 for maize, 50.63 % for sorghum, 71.71 % for rice and 89.80 % for yam; Figures in parenthesis are standard errors of regression coefficients; and cassava is the base outcome

Table 2.3 Marginal effects of climate variables on the probability of selecting crops

Crop	Base	Temperature (°C)	Rainfall (cm)
Cassava (%)	23.973	−59.24***	−12.55***
Maize (%)	52.16	−64.16***	19.49***
Sorghum (%)	10.45	56.46***	−1.39***
Rice (%)	8.71	38.36***	−3.69***
Yam (%)	4.70	28.58***	−1.85***

Source: Calculated using multinomial logit regression coefficients

Notes: The marginal change denotes 1 °C increase in temperature and 1 cm increase in rainfall, ***means significant at 1 %

The coefficients on rainfall are significantly negative for cassava, sorghum, rice and yam but indicating higher rains decreases the likelihood of selecting cassava, sorghum, rice and yam but increase the likelihood of selecting the omitted choice, maize.

Since coefficients in Table 2.2 are maximum likelihood estimates, they cannot be used to assess average impact of climate variables on crop choice. Average impact of climate variables on the probability of selecting crops in Ghana is presented in Table 2.3. The probability of selecting cassava, maize, sorghum, rice and yam are 23.97 %, 52.16 %, 10.45 %, 8.71 % and 4.70 %, respectively. Marginal increase in temperature is likely to prompt farmers to switch from cassava and maize to

cultivation of sorghum, rice and yam. The marginal increase in rainfall prompts farmers to switch from other crops to maize. That is, in warm and dry places, sorghum, rice and yam are more likely to be selected while in cooler and wet locations, maize will be more preferable. Cassava is grown in places relatively cooler and wet climate.

2.5.3 Climate Impact on Conditional Crop Revenue

The impact of climate variables on revenues from major food crops is assessed using selection bias corrected (conditional) revenue equation from Eq. (2.4). The dependent variable is the log of net revenue per hectare. The independent variables are mean monthly temperature, rainfall, household size, age, gender and educational attainment of the household head and log of farm size. Sample selection bias correction terms estimated at the first stage from the results of multinomial regressions are included as additional explanatory variables for each crop regression other than the crop for which the regression is run. This specification provides the best fit of the model.

Table 2.4 shows the results of conditional net revenue regressions of the five major crop species cultivated in Ghana. Many climate variables have statistically significant impact on net revenues of crops. Mean monthly temperature has significant positive effect on net revenues of cassava and sorghum but negative effect on revenue of other crops. Rainfall has positive influence on sorghum revenues and negative effect on cassava and maize revenues, but it has not significant effect on revenue of other crops. Household size has significant positive effect on net revenues of all crops with the exception of rice. Positive sign of household size coefficient for most crops is not surprising because family labor supports farmers during planting, weeding and harvesting periods especially in many developing countries including Ghana. Age and gender of the household head have no significant effect on revenues of all crops. That is, there is no significant difference in net revenue between older and younger farmers, and between male and female farmers. Educational attainment of the household head has significant influence on revenues of cassava and rice. Educated farmers tend to receive higher profits from rice cultivation while less educated farmers earn higher revenue from cultivation of cassava.

Apart from the factors explained earlier, farm size and crop selection terms also have statistically significant effect on some crops. Farm size has significant negative effect on earnings of all crops. Mendelsohn and Dinar (2009) attribute this to the omission in cost calculation of household labor which overstates net earnings of smaller farms. It is also explained by the higher management intensity on smaller farms as compared to larger ones. Statistical significance of the some crop selection terms indicates the presence of selection bias and this model would not produce efficient parameter estimates if this model were to be estimated using unadjusted OLS regression. The significant coefficients of sorghum and rice selection are positive and negative, respectively, in the cassava regression. This implies that farmers

Table 2.4 Conditional revenue regressions of major food crops in Ghana

Variables	Cassava	Maize	Sorghum	Rice	Yam
Intercept	−5.4124	0.8559	−101.2667***	42.1662	7.0730
	(4.6270)	(7.4926)	(25.1420)	(35.6907)	(5.1679)
Temperature (°C)	0.4336**	0.1944	3.4120***	−1.4458	−0.0254
	(0.1820)	(0.2883)	(0.8705)	(1.3444)	(0.1547)
Rainfall (cm)	−0.0802***	−0.0820**	0.7924***	−0.0178	−0.1132
	(0.0451)	(0.0347)	(0.2044)	(0.2115)	(0.0879)
Household size	0.0681***	0.0672***	0.1323***	0.0605	0.0632***
	(0.0168)	(0.0140)	(0.0263)	(0.0575)	(0.0175)
Age of household head	0.0008	0.0008365	0.0032304	0.0039505	0.0007198
	(0.0034)	0.0029603	0.0050926	0.0119072	0.0039979
Female household head	−0.0715	−0.0501	0.0122	0.6022**	0.1004
	(0.1002)	(0.1293)	(0.2172)	(0.6994)	(0.2024)
Education of household head	−0.0202***	−0.0022	−0.0442	0.1406**	−0.0051
	(0.0097)	(0.0123)	(0.0306)	(0.0643)	(0.0208)
Log of farm size	−0.8244***	−0.6615***	−0.9544***	−0.7951***	−0.5340***
	(0.0472)	(0.0436)	(0.1200)	(0.2047)	(0.0797)
Cassava selection		0.0531	0.8490	0.3129	−1.8719
		(0.3416)	(2.1969)	(1.1517)	(1.7488)
Maize selection	−0.5460		−3.0271***	1.6670**	−0.0254
	(0.5358)		(1.2440)	(1.5785)	(0.7493)
Sorghum selection	3.6744***	−0.5445		−1.3788**	−1.4418
	(1.1360)	(0.9751)		(0.9565)	(0.9522)
Rice selection	−3.2123***	−0.5843	−0.2390		2.9571**
	(1.2122)	(0.9061)	(1.5153)		(1.3547)
Yam selection	0.0277	1.0989**	2.0238***	−0.5276	
	(0.4882)	(0.5055)	(0.4327)	(0.9496)	
R^2	0.3078	0.2765	0.4159	0.3148	0.2329
F-statistic	37.52***	33.90***	20.00***	3.22***	12.39***
N	940	988	321	89	461

Source: From authors' calculations

Notes: The dependent variable is the log of net revenue per hectare; ***denotes significant at 1 %, **denotes significant at 5 % and *denotes significant at 10 %; figures in parenthesis are bootstrapped standard errors of regression coefficients

who the selection model predicts would select cassava will earn higher revenue if they actually select sorghum and lower net revenue if they actually grow rice. The coefficient of yam selection is positive in the maize regression indicating that farmers who the model predicts would select maize will actually earn higher if they actually select yam. The coefficients of maize and yam selection terms are negative and positive, respectively, in the sorghum regression indicating that farmers who the model predicts would select sorghum will actually earn lower revenue if they actually select maize and higher revenue if yam is actually selected. Farmers who actually select maize instead of rice as predicted by the model will earn higher revenue, while those who actually select sorghum will earn lower revenue. Similarly,

farmers who actually select rice instead of yam as predicted by the model will earn higher revenue.

Results of the crop revenue regressions in Table 2.4 are partly consistent with that of the crop selection equation in Table 2.3. For instance, coefficients of rainfall are negative for cassava and maize regressions, and this is matched by decreased probability of selecting these crops. Warming increases the likelihood of selecting of sorghum and this is matched by increased probability of selecting sorghum. The direction of impact of climate variables on the probability of selecting some crops is not matched by that of net revenue. Temperature and rainfall reduce the likelihood of selecting cassava and sorghum, respectively, but this is matched by corresponding effect of these climate variables on net revenue. Although climate variables have no significant effect on revenues of rice and yam, temperature and rainfall have positive and negative effect, respectively, on the probability of selecting rice and yam. The above analysis implies that farmers' choice of the major food crops is not largely motivated by profit optimizing behavior. Cultural factors[1] which sanction the use of these crops in preparing traditional dishes and other rituals in Ghanaian society may explain the irrational choice of these crops and thus defy neoclassical understanding of producer behavior.

2.6 Simulating Climate Change Impact on Expected Net Revenue

This section assesses the impact of climate change on expected net revenue (long term net revenue) in Ghana. In line with the idea of permanent income hypothesis, farmers strategize to minimize fluctuations in farm revenues by switching from crops with lower earnings over time to stabilize earnings from crop production (Friedman 1957).

To analyze climate change impact on farm outcome, results of Eqs. (2.5) and (2.6) as representing in Tables 2.3 and 2.4 together with the trend analysis of climate variables in Sect. 2.5.1 can be used. Trend analysis of climate variables shows projected increase in temperature in growing seasons of all crops (Table 2.5). Rainfall is projected to decrease in growing seasons of all crops except sorghum, which will experience an increase. Using the climate projections in Table 2.5 together with regression coefficients for climate variables from Tables 2.3 and 2.4, we can estimate the future impact of climate change on expected net crop revenue.

It can be seen from Table 2.6 that expected revenue per hectare for the five major crops is about GHS 161.86. If there is no adaptation to climate change through switching crops, expected net revenue will decrease by 13.53 %, 27.07 % and 40.60 % for 2015, 2020 and 2025 respectively. At the crop level, expected cassava

[1] There are yam festivals for many ethnic groups in Ghana. Most traditional Ghanaian dishes are prepared from cassava and maize in many locations. In the northern part of Ghana, sorghum is used in preparation of traditional dishes during funerals.

Table 2.5 Future trend of climate variables in Ghana

	Change in temperature (°C)			Change in rainfall (cm)		
	2015	2020	2025	2015	2020	2025
Cseason	0.1033	0.2067	0.3100	−0.0633	−0.1265	−0.1898
Mseason	0.0960	0.1921	0.2881	−1.0246	−2.0492	−3.0737
Sseason	0.1060	0.2121	0.3181	0.3049	0.6098	0.9147
Rseason	0.1000	0.2001	0.3001	−0.5213	−1.0426	−1.5639
Yseason	0.1073	0.2146	0.3219	−0.7002	−1.4004	−2.1007

Notes: Cseason = cassava growing season; Mseason = maize growing season; Sseason = sorghum growing season; Rseason = rice growing season; and Yseason = yam growing season

revenue will decrease by 5.03 % in 2015 to reach 15.08 % in 2025; expected maize revenue will also reduce by 14.16 % in 2015 to 28.32 % in 2025. The effect of climate change is, however, positive for sorghum, rice and yam, but it progressively worsens from 2015 to 2025. By 2015, 2020 and 2025, expected sorghum revenue will increase by 3.42 %, 6.85 % and 10.275, respectively; expected rice revenue will go up by 1.64 %, 3.29 % and 4.93 % for 2015, 2020 and 2025, respectively; and expected yam revenue is also projected to increase by 6.06 %, 12.11 % and 18.11 %, respectively. If farmers adapt to climate change by switching among the food crops in question, it will not only maximize expected net revenues of sorghum and yam alone, but also minimize the losses in cassava and maize. Sorghum revenue will increase by 21.67 % in 2015 and 65.00 % in 2025; yam revenue will also inch up by 13.14 % in 2015 and 41.99 % in 2025. It is observed that there is no much difference in expected rice revenue in terms of climate change impact with and without adaptation. With climate change adaptation, losses in expected cassava and maize revenues are projected to decline. In fact, the percentage decline in expected net revenue of cassava and maize will be less than 5 % up till 2025.

2.7 Conclusion and Recommendation

This study analyzes the impact of climate variables on the probability of selecting among five major food crops and on their net revenues in Ghana using a two-stage econometric process. At the first stage, a multinomial logit regression is used to analyze the effect of climate variables on crop choice while a selection bias corrected net revenue regression based on the multinomial logit regression is used to assess the impact of climate on revenues of farmers at the second stage. The results of the multinomial regression show that warming is likely to prompt farmers to switch from cassava and maize to the cultivation of sorghum, rice and yam while additional rainfall increases the likelihood of selecting maize instead of the other crops in question. Farmers' choice of crops tends to be partly consistent with revenue predictions. Coefficients of rainfall are negative for cassava and maize regressions, and this is matched by decreased probability of selecting these crops. Warming

Table 2.6 Impact of climate change on expected net revenue of food crops in Ghana

	No climate change adaptation			Climate change adaptation		
	2015	2020	2025	2015	2020	2025
Cassava	−8.1345 (−5.0255)	−16.2689 (−10.0511)	−24.4034 (−15.0766)	−2.2579 (−1.5865)	−5.1357 (−3.1729)	−7.7036 (−4.7594)
Maize	−22.9165 (−14.1580)	−45.8331 (−28.3161)	−68.7496 (−42.4741)	−16.6184 (−10.2670)	−33.2368 (−20.5340)	−49.8552 (−30.8010)
Sorghum	5.5418 (3.4238)	11.0836 (6.8476)	16.6255 (10.2714)	35.0683 (21.6655)	70.1366 (43.3310)	105.2049 (64.9965)
Rice	2.6617 (1.6444)	5.3234 (3.2889)	7.9852 (4.9333)	2.2745 (1.4052)	4.5490 (2.8104)	6.8235 (4.2156)
Yam	9.8025 (6.0561)	19.6051 (12.1122)	29.4076 (18.1683)	22.6542 (13.1400)	45.3083 (27.9919)	67.9625 (41.9879)
Total	−21.9060 (−13.5337)	−43.8120 (−27.0675)	−65.8120 (−40.6012)	−5.3642 (−3.3141)	−10.7284 (−6.6281)	−16.0926 (−9.9422)

Notes: All figures are in Ghana Cedis (GHS), monetary currency of Ghana. As of 2005, 1 USD = 0.92 GHS; Expected net revenue of base year (2010) is GHS161.82; figures in parenthesis are in percentage difference from base year expected revenue

increases the likelihood of selecting of sorghum and this is matched by increased probability of selecting sorghum. The direction of impact of climate variables on the probability of selecting some crops is not matched by that of net revenue. Temperature and rainfall reduce the likelihood of selecting cassava and sorghum, respectively, but this is matched by corresponding effect of these climate variables on net revenue. The above analysis implies that farmers' choice of maize and sorghum is not largely motivated by profit optimizing decisions. Cultural factors which sanction the use of these crops in preparing traditional dishes and other rituals in Ghanaian society may explain the irrational choice of these crops and thus defy neoclassical understanding of producer behavior.

Climate change impact will not have same effect across crops. Climate change is projected to raise expected revenues of sorghum, rice and yam. The positive climate change impact on sorghum and yam will be much enhanced if farmers adapt to climate change by switching among food crops. It is observed that there is no much difference in expected rice revenue in terms of climate change impact with and without adaptation. Climate change will impact negatively on expected revenues of cassava and maize, but these revenue losses will be minimized if farmers adapt by crop-switching.

From the foregoing discussions, it can be discerned that adaptation to changing climate through crop switching has beneficial outcomes in Ghana. Crop switching is an adaptation option but it is not without cost. Farmers who adopt crop switching can only use available crop varieties. In this regard, public investment in research on high-yielding, heat-tolerant and flood-prone varieties of the above mentioned food crops is suggested in order to make crop switching a beneficial exercise for farmers.

References

Bourguignon F, Fournier M, Gurgand M (2007) Selection bias corrections based on the multinomial logit model: Monte Carlo comparisons. J Econ Surv 21:174–205

Breisinger C, Thurlow J, Duncan M (2007) A 2005 social accounting matrix for Ghana. Ghana Statistical Services and International Food Policy Research Institute, Accra/Washington, http://www.ifpri.org/data/ghana03.asp. Retrieved 12 Jan 2011

CIAT (International Center for Tropical Agriculture) (2011) Predicting the impact of climate change on the cocoa-growing regions in Ghana and Cote D'Ivoire. http://www.ciat.cgiar.org/Newsroom/Documents/ghana_ivory_coast_climate_change_and_cocoa.pdf. Accessed 18 Apr 2012

Delgado CL (1995) Agricultural diversification and export promotion in Sub-Saharan Africa. Food Policy 20(3):225–243

Dubin JA, McFadden DL (1984) An econometric analysis of residential appliance holdings and consumption. Econometrica 52:345–362

Friedman M (1957) A theory of the consumption function. Princeton University Press, Princeton

Gallup J, Radelet S, Warner A (1998) Economic growth and the income of the Poor. CAER II Discussion Paper 36, Harvard Institute for International Development, Boston

GEPA (Ghana Environmental Protection Agency) (2001) Ghana's initial national communications report. United Nations Framework Convention on Climate Change, Accra

Ghana Environmental Protection Agency (GEPA) (2007) Climate change and the Ghanaian economy. Policy Advice Series, vol 1. Ghana Government Policy Document, Accra

Ghana Statistical Service (GSS) (2005) Ghana living standards survey V. Ghana Government, Accra

Heckman JJ (1979) Sample selection bias as a specification error. Econometrica 47(1):153–162

Kurukulasuriya P, Mendelsohn R (2006) A ricardian analysis of the impact of climate change on cropland. CEEPA Discussion Paper 8, CEEPA, University of Pretoria. http://www.ceepa.co.za/docs/CDP8.pdf. Accessed 15 June 2011

Lee LF (1983) Generalized econometric models with selectivity. Econometrica 51:507–512

Mendelsohn R, Dinar A (1999) Climate change, agriculture, and developing countries: does adaptation matter? World Bank Res Obs 14(2):277–293

Mendelsohn R, Dinar A (2009) Climate change and agriculture: an economic analysis of global impacts, adaptation and distributional effects. Edward Elgar Publishing Ltd, Cheltenham/Northampton

Mendelsohn R, Dinar A, Sanghi A (2001) The effect of development on the climate sensitivity of agriculture. Enviro Devel Econ 6:85–101

Mendelsohn R, Neumann J (1999) The impacts of climate change on the US economy. Cambridge University Press, Cambridge

Mendelsohn R, Nordhaus W, Shaw D (1994) The impact of global warming on agriculture: a ricardian analysis. Am Econ Rev 84:753–771, http://www.geofaculty.org:16080/figures/Rood_Climate_Change_AOSS480_Documents/Mendelsohn_Climate_Change_Agriculture_AmEconRev_1994.pdf. Accessed 15 June 2011

Nankani G (2009) Challenges of the Ghanaian economy. http://www.ghanabusinessnews.com/2009/02/25/the-challenge-of-agriculture-in-ghana-what-is-to-be-done/. Accessed 12 July 2012

NEPAD (2009) Comprehensive Africa Agricultural Development Programme (CAADP) Annual Report. http://www.nepad-caadp.net/pdf/CAADP_AR2010_WEB.pdf. Accessed 12 Aug 2012

Sagoe R (2006) Climate change and root production in Ghana. http://www.nlcap.net/fileadmin/NCAP/Countries/Ghana/ROOT_TUBERS_DRAFT_FINAL_REPORT.pdf. Accessed 9 June 2012

Sanghi A, Mendelsohn R, Dinar A (1998) The climate sensitivity of Indian agriculture. In: Dinar AR, Mendelsohn R, Evenson R, Parikh J, Sanghi A, Kumar K, McKinsey J, Lonergan S (eds) Measuring the impact of climate change on Indian agriculture. World Bank Technical Paper 402. World Bank, Washington

Seo SN, Mendelsohn R (2007) Measuring impacts and adaptations to climate change: a structural ricardian model of African livestock management. Agric Econ 38:151–165, http://dev.thegncs.org/sitefiles/file/Kenya_Adaptation_CRM_Livestock_Seo%20et%20al__2007.pdf. Accessed 15 June 2011

Seo SN, Mendelsohn R (2008) A structural ricardian analysis of climate change impacts and adaptations in African agriculture. World Bank Policy Research Series Working Paper 4603, Washington. http://www-wds.worldbank.org/servlet/WDSContentServer/WDSP/IB/2008/04/17/000158349_20080417151505/Rendered/PDF/WPS4603.pdf. Accessed 15 June 2011

Train K (2003) Discrete choice methods with simulation. Cambridge University Press, Cambridge

UNECA (2005) Economic report on Africa 2005: meeting the challenges of unemployment and poverty in Africa. Addis Ababa, Ethiopia

Zheren W (2008) Self-selection and earnings of migrants: evidence from rural China. Discussion Paper 08–25. Graduate School of Economics and Osaka School of International Public Policy (OSIPP), Japan

Chapter 3
Climate Variables and Their Impacts on Yield of Food Crops in Makwanpur and Ilam Districts of Nepal

Suman Lal Shrestha and Keshav Lall Maharjan

Abstract Climate change and variability is predicted to have negative impact mostly in countries which depend on rain-fed agriculture. This chapter intends to assess impact of climate variables on the yield of major food crops in two hilly districts: Makwanpur and Ilam of Nepal based on district-level time series data from 1978 to 2008. Trend analysis of climate variables shows that, in both Makwanpur and Ilam districts, temperature (minimum and maximum) is increasing both in summer and winter crop growing seasons with exception in Ilam district where minimum temperatures in both seasons are declining. Except for summer rainfall in Makwanpur, rainfall is decreasing in both the districts. This trend of climate variables tends to influence the yields of major food crops; paddy, wheat, maize, millet, barley and potato. The results of this study show that only minimum temperature has significant effect on yields of major food crops in Makwanpur. Marginal rise in minimum temperature reduces yields of paddy and maize but has no significant impact on yields of other crops in Makwanpur. Maximum temperature and rainfall tend to influence the yield trends of some major food crops in Ilam district. Higher maximum temperature tends to increase maize yield while rainfall tends to increase yields of paddy and wheat in Ilam district. Apart from paddy, the combined effect of climate variables indicates that yields of all other major crops are declining in Makwanpur. In Ilam, climate variables reduce the yields of paddy, wheat and millet while that of maize, potato and barley are increased.

Keywords Climate variables • Crop yield • Ilam • Makwanpur • Multiple regression analysis • Nepal

---

Findings discussed in this chapter are presented in the Symposium on climate change, organic agriculture, and food security 23, 2011, Rampur, Chitwan, Nepal and published in Journal of International Development and Cooperation, Special Issue, 18 (4), 3754.

S.L. Shrestha (✉) • K.L. Maharjan
Graduate School for International Development and Cooperation, Hiroshima University, Hiroshima, Japan
e-mail: sumanlal_shrestha@hotmail.com

K.L. Maharjan (ed.), *Communities and Livelihood Strategies in Developing Countries*,
DOI 10.1007/978-4-431-54774-7_3, © Springer Japan 2014

3.1 Introduction

Climate change is a change in average weather conditions over time, which is attributable to natural forces or human activity (IPCC 2001). It has been established that the climate change over the past century is due to anthropogenic activities and it affects various natural as well as man-made processes and structures. A climate change will affect natural resources including water and forest which will ultimately affect livelihoods. Climate change will have different impact on various aspects of human activities, with some sectors being adversely affected while others gaining from the new climate. As climate is one of the main factors of agricultural production, it is believed that it will be more susceptible to climate change and variability (Mendelsohn 2009; Deschenes and Greenstone 2006).

Agriculture is very sensitive to changes in temperature, precipitation and climatic extremes like drought and flood (USEPA 2011). The effect of climate change on agriculture will be direct as well as indirect (Gbetibouo and Ringler 2009). The direct effect of climate change on agriculture will be through changes in temperature and precipitation (WICCI 2009). The change in temperature and precipitation will affect the phenology and timing of crop development as well as through changes in atmospheric CO_2 concentration (IPCC 2007). Also, changes in the global climate will affect temporal patterns of temperature and rainfall at the regional level (IPCC 1996) which will affect crop production. Further, due to climate variability there will be shortening of growing periods which will reduce crop yield (Peiris et al. 1996). Climate change will have impact on the growing season in subtropical regions by changing seasonal temperature and precipitation (Reilly and Schimmelpfennig 1999). Indirect effects are incidence of new diseases, pests and weeds and decrease in water availability which will have negative impact on crop yield. Thus, yield and quality of food-crops will reduce in general which will exacerbate vulnerability in food supply (Joshi et al. 2011). In addition to this, research by Nelson et al. (2009) using the Decision Support System for Agro-technology Transfer (DSSAT) model stated that by 2050 climate change will have negative effect on crop yields in global agriculture context and ultimately resulting in reduced levels of the world food supply.

3.2 Climate and Agriculture in Nepal

Nepal is a mountainous country where majority of people live in rural areas. In 2009, only 17.72 % of people were living in urban areas. The agricultural land in Nepal is 42,100 km^2 (WB 2011). Agriculture is the main livelihood option of most rural people. At the national level, economy of Nepal is significantly dependent on agriculture. Approximately, 33.85 % of GDP came from agriculture in 2009, down from 40 % in 2000. Irrigation covers only 27.74 % of the total agricultural land in Nepal (WB 2011). Therefore people mostly rely on rain-fed agricultural system.

Further, irrigation is mainly the small type managed by the farmers' community itself (Bhandari and Pokharel 1999).

Analyses of data from 1976 to 2005 indicate that temperature in Nepal has increased by 1.6 °C which is well above global average (Maharjan et al. 2009). In addition, warming trend in Nepal is more pronounced in autumn and winter. Nepal experiences monsoonal rains during June–September which is around 80 % of total annual rainfall and very low precipitation during December–February (MoPE 2004). An analysis of temperature trends from 1978 to 2005 shows that maximum temperature is increasing faster in the higher altitudes than in lower altitudes (Practical Action 2009). While annual minimum temperature trend of the country is decreasing in the northern (higher altitude) part, it is increasing in most area of the southern lower altitude part of Nepal (Practical Action 2009). This shows that there is increasing temperature anomaly in the country. Further, in 2009, there was positive temperature anomaly of over 1 °C recorded in the north-western part and some areas of Eastern, Central and Western part of Nepal (Department of Hydrology and Meteorology 2009). Nepal climate projection using general circulation model (GCM) showed that there was significant increase in temperature projection for 2030, 2050 and 2100 (Agrawala et al. 2003). A study carried out by Chaulagain (2006) in four meteorological stations (Rampur, Kathmandu, Daman and Langtang) from 1971 to 2000 shows that there was decrease in number of rainy days in three stations while there was positive trend on number of rainy days from July to August in all stations, indicating longer duration of dry spells and higher rainfall intensity in some months.

The effect of climate change in agriculture will mostly be detrimental as it is highly dependent on weather condition due to extreme rainfall (Maharjan et al. 2009). According to Regmi (2007), there was 2 and 3.3 % decrease in paddy and wheat production respectively in 2005 as country experienced drought. Also, paddy decreased by 27–39 % in Eastern Terai in 2006 due to drought (Regmi 2007). Sharma and Shakya (2006) states that changes in water availability in monsoon, pre-monsoon and post-monsoon seasons and shifting of the hydrograph have a direct impact on Nepalese agriculture. According to Maharjan et al. (2009), warming will increase incidence of pests and diseases and reduce physiological performance thereby impacting negatively on crop yield. A study conducted by Joshi et al. (2011) to examine the effect of climatic variables on yield of major food crops of Nepal using multiple regression model shows that the current climatic trend increases wheat and barley yields whereas increased summer rainfall and temperature suppressed the yield growth of maize and millet. The study concludes that the food crops are negatively affected by climate change except for paddy which thrives on water logging condition (Joshi et al. 2011). Further, in a study by Thapa and Joshi (2010) using Ricardian method notes that the impact of climate change on agriculture varied across different climatic zones in Nepal.

As climate is an integral part of any system, natural or man-made, any slight change in climate will have far-reaching consequences. Nepal is experiencing rapid changes and pressures from climate change in different sectors (Maharjan et al. 2009). As agriculture is one of the sectors that are more dependent on climate,

Table 3.1 Categories of adaptation practices

Categories	Adaptation practices
Agriculture management	Manures and composting
	Seedbed method
	Intercropping
	Crop rotation/fallowing
	Bench terrace
Water harvesting/water use efficiency	Supplemental irrigation
	Mini-ponds
	Soil and water conservation
	System of rice intensification
	Drought resistant varieties
Crop intensification	Green manure
	Inorganic fertilizer
Alternate enterprise	Cash crop plantation
	Diversify livelihood options
Alternate energy source	Community based biogas and community forestry, tree plantation
Household level energy efficiency	Improved cooking stove
Post-harvest practices	Seed storage for higher viability

Source: Baas and Ramasamy (2008), Bryan et al. (2011)

farmers, as a segment of society, are more prone to its adverse impact. The change in agricultural production due to climate change will have an effect on farmers both economically as well as socially. For farmers to cope with these climate change effect it is vital that adaptation strategies be considered. The adaptation strategies and practices depend on geographic location and socio-economic condition. Some adaptation strategies and practices may be viable to one region but might not be viable to other region so regional and social consideration should be given before implementing these strategies and practices. Some of the broad adaptation strategies and practices that farmers are practicing according to different literatures are shown in Table 3.1.

It is vital to have information regarding impact of climate change and the changes that farmers are noticing in the environment as well as farming. Also, it is equally important to understand whether farmers are observing the changes in the environment or not. From the household survey in Chitlang VDC (village development committee) of Makwanpur district and Namsaling VDC of Ilam district it was seen that farmers have started to notice some changes in the environmental as well as farming practices. In Namsaling, farmers have started to notice that mosquito which used to be seen in the lower altitude in the past are now also seen at higher altitude. They have also noticed fruits are ripening about 15 days earlier than before and fruits like oranges which were only found in lower altitudes before are also found in higher altitudes now. They have also noticed that broom grass has also ripened earlier than it used to. Similarly in case of Chitlang farmers have noticed that maize harvesting period has shifted 1 month late due to late onset of rainfall. Also some

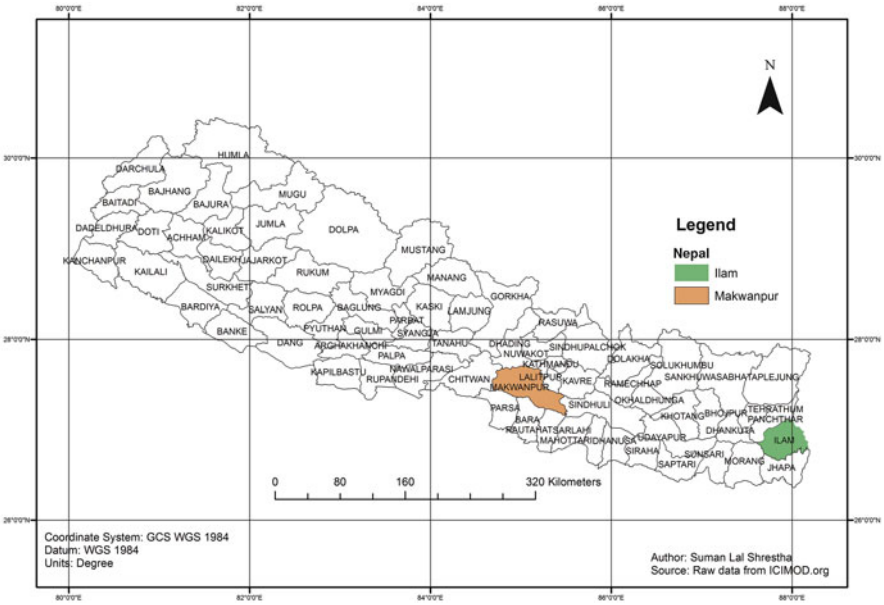


Fig. 3.1 Map of Nepal showing study area

Table 3.2 Adaptation practices found in Chitlang VDC and Namsaling VDC

Categories	Adaptation practices
Agriculture management	Manures and composting
	Seedbed method
	Bench terrace
Water harvesting/water use efficiency	Supplemental irrigation
	Drought resistant varieties
Crop intensification	Green manure
	Inorganic fertilizer
Alternate enterprise	Cash crop plantation
	Diversify livelihood options
Alternate energy source	Community forestry, tree plantation

Source: Field survey 2010

of the common adaptation practices that are observed in both the study area are shown in Table 3.2.

The household survey showed that there have been certain changes in the environment that the farmers are noticing and are adapting to these changes as per their ability. But, further it is very important to understand how climatic variables are having impact on the farmers for which there are different methods that are used. One of the commonest methods in agricultural research is analysing its impact on crop yield. In this vein, it is imperative to understand how yields of major food crops are responding to change in climate variables over time. In addition, knowing the

local level impact of climate change on major food crops will help in anticipating future food security. This chapter dwells on the climate variables, especially temperature and rainfall, their changing nature and how such changes are affecting yields of major food crops in two hilly districts of Nepal.

3.3 Methodology

This study uses multiple regression analysis to investigate the impact of climate variables on yields of major food crops in Nepal. Historical temperature, precipitation and yield data covering the period 1978–2008 for the two study districts, Ilam and Makwanpur, is used for the climate impact analysis. A simple linear regression analysis is made to establish the trend of maximum temperature, minimum temperature, and precipitation of summer (May–August) and winter (November–February) seasons in Ilam and Makwanpur district from 1978 to 2008. The summer and winter seasons were determined based on cropping seasons of Nepal as given by Joshi et al. (2011). Similarly, simple linear regression method was used for the trend analysis of yields of the major food crops; paddy, maize, wheat, millet, barley and potato. To analyse the effect of the climate variables on the yields of the major food crops in Ilam and Makwanpur district, multiple regression analysis as in Eq. (3.1) is used as per the specification of Nicholls (1997).

$$\Delta W = \beta_1 \Delta R + \beta_2 \Delta T_{\max} + \beta_3 \Delta T_{\min} \tag{3.1}$$

The variables, ΔW, ΔR, ΔT_{max} and ΔT_{min} denote changes in yield, rainfall, maximum temperature and minimum temperature, respectively. β_1, β_2 and β_3 are the coefficient of rainfall, maximum temperature and minimum temperature, respectively.

In order to establish causal effect of climate variables on crop yield, yield and climatic variables were de-trended by calculating the first difference (year to year changes) in all relevant variables as in Eq. (3.1). This helps to nullify influences of non-climatic factors like new cultivars and changes in management practices of crops. According to Nicholls (1997), using year-to-year change will remove long-term confounding influence of management practices which are likely to create spurious correlation among variables. In climate change impact studies, the climatic variables that are mostly used are the temperature, rainfall and solar radiation. However, solar radiation has direct relation with maximum and minimum temperature due to radioactive cooling (Peng et al. 2004). So, in this study, only temperature and rainfall data are considered. Further, to capture the differential effect of day and night temperature, minimum and maximum air temperature is used for this study (Peng et al. 2004).

In analysing changes in crop productivity due to the effect of environmental changes, crop simulation and regression models are often used (Joshi et al. 2011). Schlenker and Roberts (2008) observe that crop simulation study helps in understanding physiological effects of high temperature on crops yield but it is not

capable of incorporating small (marginal) changes in temperature usually associated with global warming. On the other hand it is argued that, although regression analysis is based on historical climatic and yield data, predictions of yield changes due to climatic variables for specific crops are relatively accurate (Boubacar 2010; Isik and Devadoss 2006; Lobell and Asner 2003; Mendelsohn et al. 1994). Another advantage of using regression analysis is that it is replicable in other countries or regions (Nicholls 1997). In developing countries like Nepal where primary livelihood of most people is agriculture, generally there is inadequate econometric analysis of climate change impact on agriculture. Hence, in this study, a regression model is used to predict change in yield in response to change in climate variables based on historical climatic and yield data for the two study districts mentioned earlier. In this study, the major food crops of Nepal, paddy, maize, millet, wheat, barley and potato, as stated by Subedi (2003) are taken for the analysis. Further, paddy, maize, potato and millet are taken as summer crops grown from May to August while wheat and barley are taken as winter crops cultivated from November to February (Joshi et al. 2011). The data for temperature and rainfall was taken from the Department of Hydrology and Meteorology (DHM), Nepal, whereas yield data was compiled from different publications of the Ministry of Agriculture and Cooperatives (MoAC).

3.4 Results and Discussion

3.4.1 Trend Analysis of Climatic Variables

The trend analysis of climate variables was carried out for each growing season of the major food crops of study districts. In Makwanpur district, time-series data on temperature from two meteorological stations, Daman and Hetauda, were taken. Rainfall data were obtained from four additional meteorological stations, Chisapani Gadhi, Markhu Gaun, Makwanpur Gadhi and Beluwa making a total of six stations. In case of Ilam district, data from two stations, Ilam Tea State and Kanyam Tea State, were used to make a trend analysis of temperature, whereas data from one additional station, Himali Gaun, totalling three stations was used for the trend analysis of rainfall.

Seasonal trend of all climatic variables differs between the sample districts. In Makwanpur, all the coefficients, except winter rain, are positive which indicates that there is increase in both temperature and rainfall over the study periods as depicted in Figs. 3.2 and 3.3. Here, minimum and maximum temperatures are increasing steadily over the period at the annual rate of 0.06 °C and 0.09 °C, respectively during summer and 0.09 °C and 0.14 °C respectively, during winter. Trend of summer rain is high indicating increase in rainfall over the period as in Fig. 3.3. However, it is observed that there exists high inter-annual variation in summer rain. This rainfall variability during summer will have adverse impact on agriculture since a significant proportion of cultivable land is under rain-fed agriculture. Winter rain, on the other hand, shows steady decline overtime with less inter-annual variation.

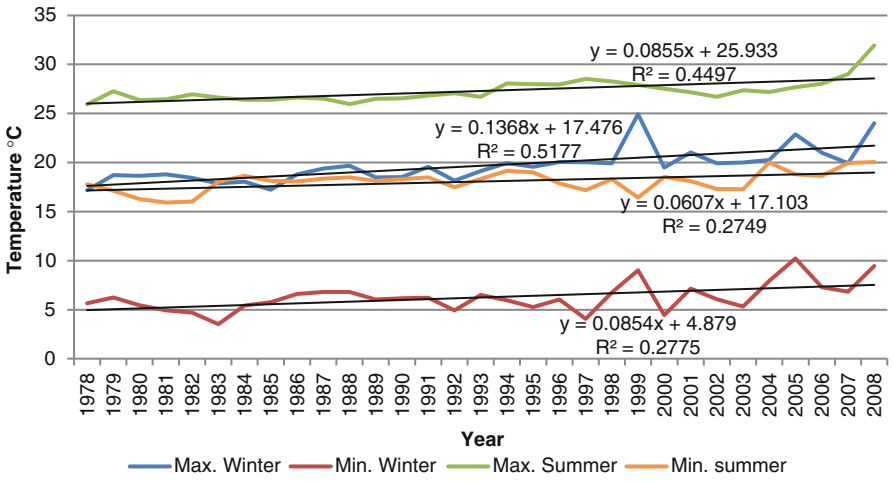


Fig. 3.2 Temperature trend in Makwanpur from 1978 to 2008

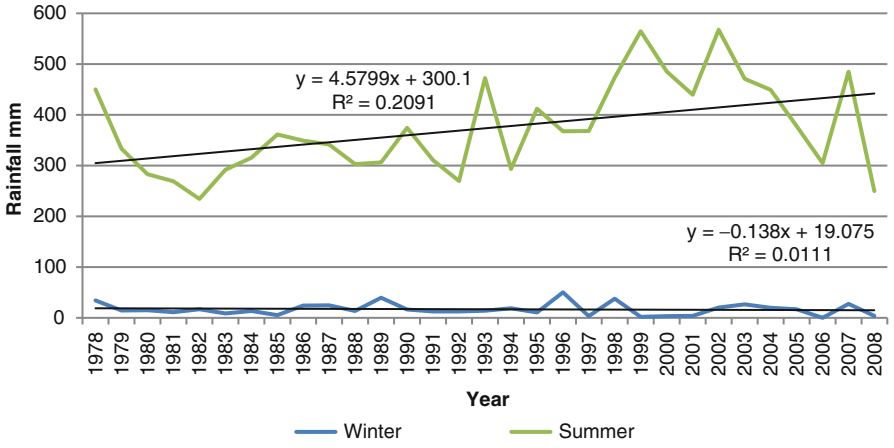


Fig. 3.3 Rainfall trend in Makwanpur from 1978 to 2008

Climate variables have negative trend coefficient in Ilam. Here, though maximum temperatures in both seasons are increasing at the annual rate of 0.05 °C and 0.07 °C, respectively, minimum temperature is decreasing in both the seasons. This indicates that gap between the day and night temperature is widening which is likely to have adverse effects on crop yield (Abrol and Ingram 1996). Rainfall for both seasons is also in declining trend in Ilam, which may hamper agricultural activities under rain-fed conditions (Figs. 3.4 and 3.5).

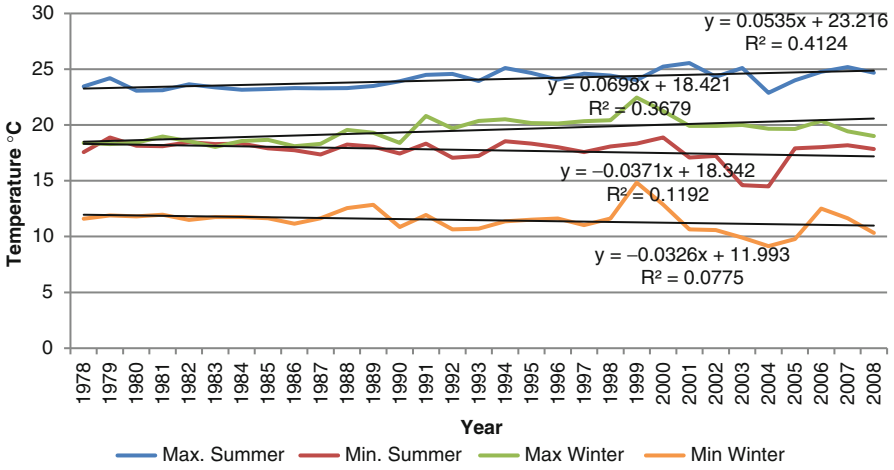


Fig. 3.4 Temperature trend in Ilam district from 1978 to 2008

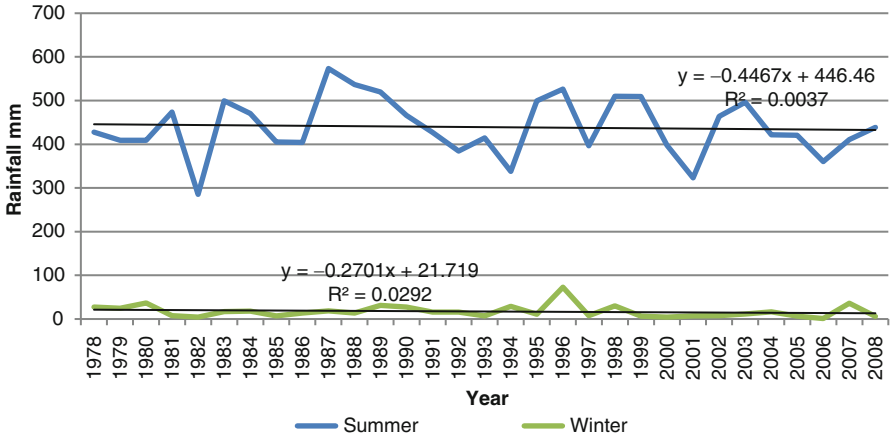


Fig. 3.5 Rainfall trend in Ilam district from 1978 to 2008

3.4.2 Trend Analysis of Yield of Major Food Crops in Nepal

This section presents a trend analysis of yields of major food crops, namely paddy, wheat, maize, millet, barley and potato, in the studied districts. The analysis shows that, in case of Makwanpur district, yields of paddy and maize are slightly decreasing by 12.56 and 10.047 kg/ha/year, respectively, while other major food crops like millet, potato, wheat and barley are increasing at annual rate of 6.4, 226.58, 34.4, and 17.48 kg/ha, respectively (Figs. 3.6 and 3.7). In case of both districts, coefficients of potato yield are quite high followed by wheat.

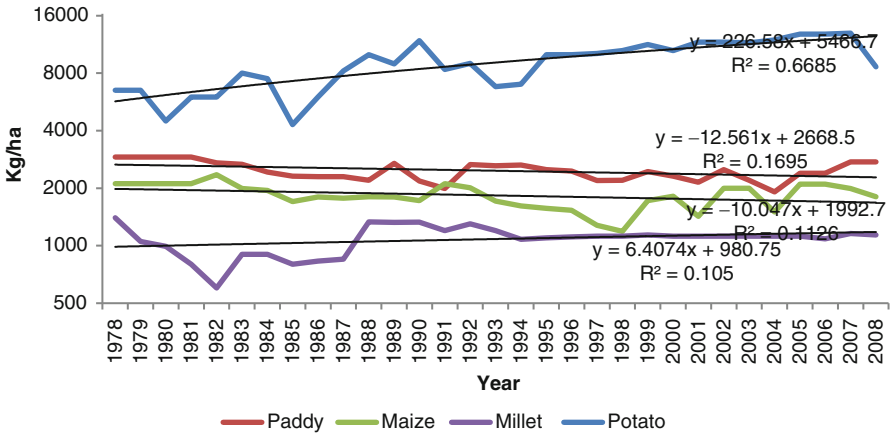


Fig. 3.6 Summer food crops yield trend in Makwanpur district from 1978 to 2008

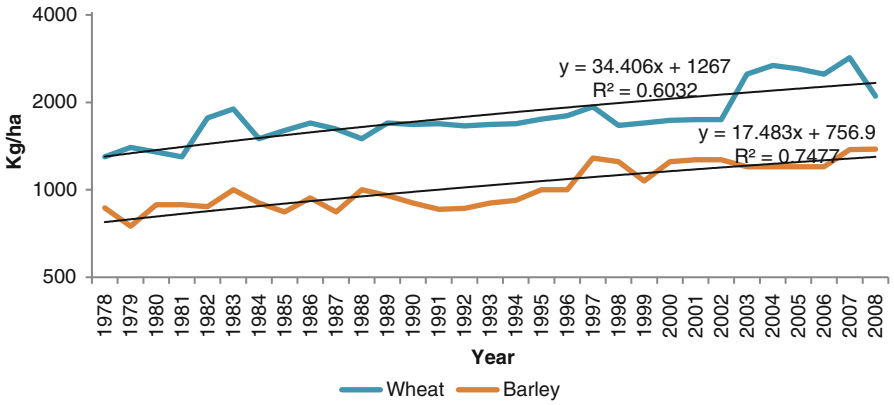


Fig. 3.7 Winter food crops yield trend in Makwanpur district from 1978 to 2008

In Ilam district, yields of paddy and potato are increasing at the rate of 220.65 and 14.75 kg/ha/annum, respectively, whereas yields of maize and millet are experiencing a decline at the rate of 12.53 and 1.11 kg/ha/annum, respectively (Fig. 3.8). Winter crops, on the other hand are in increasing trends. Yields of wheat and barley are increasing at the rate of 26.01 and 1.11 kg/ha, respectively (Fig. 3.9).

3.4.3 Effect of Climate Change on Yield of Major Food Crops in Makwanpur

Table 3.3 shows the effect of temperature and rainfall on crop yields in the study districts. It was seen that maximum temperature has positive relationship with yields

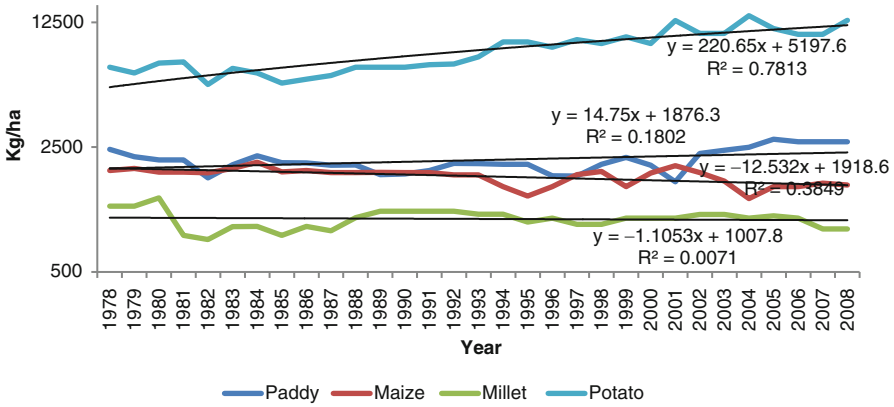


Fig. 3.8 Summer food crops yield trend in Ilam district from 1978 to 2008

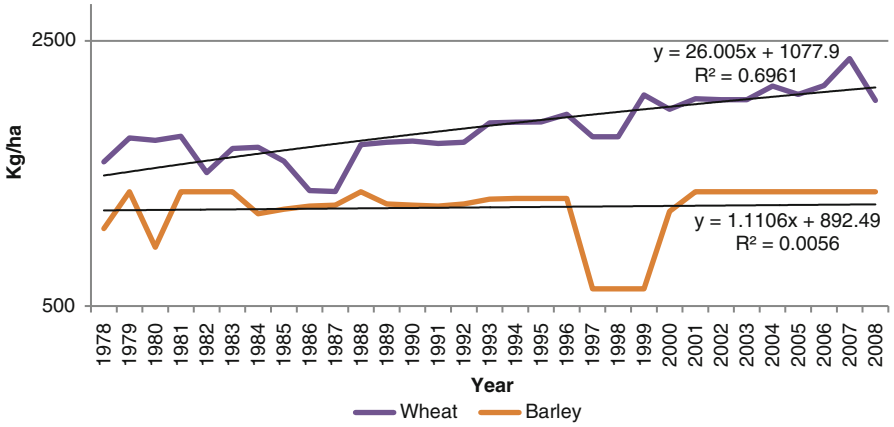


Fig. 3.9 Winter food crops yield trend in Ilam district from 1978 to 2008

Table 3.3 Effect of climatic variables on yield of major food crops in Makwanpur

Crops	Max temp coefficient	P value	Min temp coefficient	P value	Rainfall coefficient	P value	Change in yield
Maize	−27.88	0.70	−129.83	0.01***	−0.00	0.99	−311.63
Paddy	81.18	0.29	−93.11	0.05**	0.69	0.24	214.54
Wheat	17.46	0.72	−63.43	0.20	3.27	0.27	−331.06
Millet	−60.44	0.16	23.81	0.36	−0.00	0.99	−124.93
Potato	−666.78	0.21	5.97	0.98	1.97	0.62	−4,603.67
Barley	−9.57	0.60	−19.25	0.30	−0.37	0.74	−197.70

Note: ***1 % level of significance, **5 % level of significance

Table 3.4 Effect of climate change on yield of major food crops of Nepal in Ilam

Crops	Max temp coefficient	P value	Min temp coefficient	P value	Rainfall coefficient	P value	Change in yield (kg/ha)
Maize	89.46	0.04**	12.45	0.66	0.07	0.84	28.59
Paddy	−60.79	0.26	54.85	0.14	1.18	0.01***	−246.96
Wheat	24.38	0.70	51.82	0.25	2.93	0.061*	−136.25
Millet	−19.58	0.56	9.58	0.67	−0.07	0.80	−5.40
Potato	−88.23	0.88	−147.76	0.71	−3.11	0.50	508.37
Barley	−17.03	0.75	−2.30	0.95	0.65	0.61	24.74

Note: *1 % level of significance, **5 % level of significance, ***10 % level of significance

of paddy and wheat with coefficients of 81.17 and 17.45, respectively, whereas its relationship with yields of maize, millet, potato and barley are negative with coefficient of −27.88, −60.43, −666.78 and −9.56, respectively. Further, minimum temperature has negative relationship with yields of maize, paddy, wheat and barley, with coefficients of −129.82, −93.10, −63.42 and −19.25, respectively. Minimum temperature, however, has positive relationship with yields of millet and potato having coefficients of 23.80 and 5.97, respectively. The analysis also shows that the rainfall has negative relationship with yields of maize, millet and barley with coefficients of −0.0001, −0.001, and −0.373, respectively but are not significant. Though the majority of the coefficient did not have significant p-value, this analysis showed the direction in which climate change is having effect on the yield of major food crops of the districts.

The coefficients of temperature and rainfall were utilized to quantify combined effect of climate variables on yields of the food crops. It can be seen from Table 3.3 that, except paddy, climate variables adversely affected yields of all other major food crops. Climate variables have positive impact on yield of paddy, increasing it by 214.52 kg/ha whereas decreasing yields of maize, wheat, millet, potato and barley by 311.63, 331.06, 124.93, 4,603.67, 197.70 kg/ha, respectively.

3.4.4 Effect of Climate Variables on Yield of Major Food Crops in Ilam

Table 3.4 shows the impact of climatic variables on the yields of major food crops in Ilam district. The maximum temperature tends to have positive relationship with yields of maize, wheat and potato having coefficients of 89.46, 24.38 and 239.10, respectively. Only maize yield has significant p-value with maximum temperature at 5 % level of significance, whereas other crops do not have significant p-value. The minimum temperature has negative relationship with yield of potato and barley with coefficients of −246.231 and −2.298, respectively, whereas yields of maize, paddy, wheat and millet have positive relationship with coefficients of 12.45, 54.84, 51.82, and 9.57, respectively, but none of them have significant p-values.

Furthermore, rainfall is inversely related with yields of millet and potato with coefficients of –0.07 and −3.11, respectively, while yields of maize, paddy, wheat and barley, are directly related with rainfall, having coefficients of 0.07, 1.18, 2.93 and 0.65, respectively. Only yields of paddy and wheat have significant relationship with rainfall at 1 % level of significance and 10 % level of significance, respectively, while yield of other crops did not have any significant p-values.

The combined effects of climate variables on yields of maize, potato and barley are positive, increasing yields of these crops by 28.59, 508.37, 24.74 kg/ha, respectively. Climate impacts on yields of paddy, wheat, and millet are reduced by 246.961, 136.251, 5.399 kg/ha, respectively. It was seen that in Makwanpur district except paddy all other major food crops were negatively affected by climate variables, while in Ilam, paddy, wheat and millet were negatively affected by climate variables.

3.5 Conclusion

This study uses multiple regression model to analyze the effect of climate variables on yields on major food crops in two districts of Nepal, Makwanpur and Ilam. The trend analysis of climatic variables shows that both minimum and maximum temperatures are increasing. This indicates that winters are warming at faster rate than summers in Makwanpur district. The summer rainfall in Makwanpur district was found to be increasing while winter rainfall tending to be decreasing slightly, indicating that higher rainfall intensity during summer and reduced rainfall levels in winter in Makwanpur district. In Ilam district, maximum temperature in both winter and summer is increasing while minimum temperature in both winter and summer is decreasing. This implies that days are becoming warmer and nights getting cooler, indicative of more extreme weather. Both winter and summer rains are in a decreasing trend in Ilam district.

A simple linear regression analysis of yield trend of major food crops in both the districts shows they are changing. In Makwanpur district, yield of paddy and maize is decreasing while millet, potato, wheat and barley yields are increasing. The decrease in yield of paddy can be attributed to the frequent occurrence of drought over the course of time. Also, there was sharp increase in the yield of potato which is mainly attributed to the new varieties of potato and the use of fertilizers and pesticides as per the farmers in the study VDCs. In the case of Ilam district, yields of maize and millet are found to be decreasing while paddy, potato, wheat and barley are increasing. The sharp increase in potato yields in Ilam district can be explained by the use of high yielding varieties, fertilizers and pesticides.

The trend of climatic variables tends to have some level of influence on yields of major food crops in both districts. In Makwanpur district, climatic variables had negative relationship with yields of all the major food crops of Nepal except paddy. In the case of Ilam district, climate variables have negative relationship on yield of all the major food crops except maize and potato. The decrease in yield of paddy in Ilam district can be attributed to declining levels of rainfall. Though majority of the

climatic variables do not have significant p-values, they at least indicate the direction of impact of those variables. Despite the suppression of yield by the climatic variables in some cases, most of these food crops overcome such suppression, but crops like paddy, maize and millet were not able to overcome such depression leading to decrease in overall yield. This implies the necessity to incorporate both climatic and managerial factors that are changing over the time in order to gain better understanding of climate impact.

References

Abrol YP, Ingram KT (1996) Effects of higher day and night temperatures on growth and yields of some crop plants. In: Bazzaz F, Sombroek W (eds) Global climate change and agricultural production: direct and indirect effects of changing hydrological, pedological and plant physiological processes. Wiley, West Sussex, pp 123–140

Agrawala S, Raksakulthai V, Aalst MV, Larsen P, Smith J, Reynolds J (2003) Development and climate change in Nepal: focus on water resources and hydropower. OECD, Paris

Baas S, Ramasamy S (2008) Community based adaptation in action. A case study from Bangladesh. Food and Agriculture Organization of the United Nations/Department of Agriculture Extension, Rome/Dhaka

Bhandari RP, Pokharel DR (1999) Modernization of farmer-managed irrigation systems in Nepal: process and learning. FAO. http://www.fao.org/DOCREP/003/X6626E/x6626e14a.htm. Accessed 2 Feb 2010

Boubacar I (2010) The effects of drought on crop yields and yield variaiblity in Sahel. In: The Southern Agricultural Economics Association annual meeting, The Southern Agricultural, Orlando

Bryan E, Ringler C, Okoba B, Koo J, Herrero M, Silvestri S (2011) Agricultural management for climate change adaptation, greenhouse gas mitigation, and agricultural productivity. Insights from Kenya. IFPRI, Washington

Chaulagain NP (2006) Impacts of climate change on water resources of Nepal. The physical and socioeconomic dimensions. Flensburg University

Department of Hydrology and Meteorology (2009) Preliminary weather summary of Nepal. DHM, Kathmandu

Deschenes O, Greenstone M (2006) The economic impacts of climate change: evidence from agricultural output and random fluctuations in weather. Am Econ Rev 97(1):354–385, http://www.econ.ucsb.edu/~olivier/DG_AER_2007.pdf. Accessed 1 June 2011

Gbetibouo GA, Ringler C (2009) Maping South African farming sector vulnerability to climate change and variability. A Discussion Paper. IFPRI. http://www.ipri.org/sites/default/files/publications/rb15_03.pdf. Accessed 30 Mar 2011

IPCC (1996) Climate change 1995: the science of climate change. Contribution of Working Group I to the second assessment report of the Intergovernmental Panel on Climate Change. IPCC, Cambridge. http://www.ipcc.ch/ipccreports/sar/wg_I/ipcc_sar_wg_I_full_report.pdf. Accessed 20 May 2011

IPCC (2001) Climate change 2001: Impacts, adaptation and vulnerability. Contribution of Working Group II to the Third Assessment REport of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge

IPCC (2007) In: Parry ML, Canziani OF, Palutikof JP, Van der Linden PJ, Hanson CE (eds) Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge. http://www.ipcc.ch/publications_and_data/publications_ipcc_fourth_assessment_report_wg2_report_impacts_adaptation_and_vulnerability.htm. Accessed 25 May 2011

Isik M, Devadoss S (2006) An analysis of the impact of climate change on crop yields and yield variability. Appl Econ 38(7):835–844
Joshi NP, Maharjan KL, Piya L (2011) Effect of climate variables on yield of major food-crops in Nepal: a time-series analysis. J Contemp India Stud Space Soc 1:19–26
Lobell DB, Asner GP (2003) Climate and management contributions to recent trends in U.S. agricultural yields. Science 299(5609):1032
Maharjan KL, Joshi NP, Piya L (2009) Sources of climate change, its impact, and mitigation issues in Nepal. In: Singh S, Sharma MK (eds) Climate change: Asia perspective. Rawat Publications, Jaipur, pp 57–77
Mendelsohn R (2009) The impact of climate change on agriculture in developing countries. J Nat Resour Policy Res 1(1):5–19
Mendelsohn R, Nordhaus WD, Shaw D (1994) The impact of global warming on agriculture: a Ricardian analysis. Am Econ Rev 84(4):753–771
MoPE (2004) Initial national communication to the Conference of the Parties of the United Nations Framework Convention on Climate Change. Ministry of Population and Environment (MoPE), Kathmandu
Nelson GC, Rosegrant MW, Koo J, Robertson R, Sulser T, Zhu T, Lee D (2009) Climate change impact on agriculture and costs of adaptation. International Food Policy Research Institute (IFPRI), Washington. 10.2499/0896295354
Nicholls N (1997) Increased Australian wheat yield due to climate trends. Nature 387:484–485, http://www.nature.com/nature/journal/v387/n6632/pdf/387484a0.pdf. Accessed 2 Feb 201
Peiris DR, Crawford JW, Grashoff C, Jefferies RA, Porter JR, Marshall B (1996) A simulation study of crop growth and development under climate change. Agric Forest Meterol 79:271–287
Peng S, Huang J, Sheehy JE, Laza RC, Visperas RM, Zhong X (2004) Rice yields decline with higher night temperature from global warming. Proc Natl Acad Sci U S A 101(27):9971–9975, http://www.pnas.org/content/101/27/9971/full.pdf+html. Accessed 5 Jan 2011
Practical Action (2009) Temporal and spatial variability of climate change over Nepal (1976–2005). Practical Action Nepal Office, Kathmandu
Regmi HR (2007) Effect of unusual weather on cereal crop production and household food security. J Agric Environ 8:20–29
Reilly JM, Schimmelpfennig D (1999) Agricultural impact assessment, vulnerability and the scope for adaptation. Clim Change 43(4):745–788
Schlenker W, Roberts MJ (2008) Estimating the impact of climate change on crop yields: the importance of non-linear temperature effects. NBER Working Paper 13799. National Bureau of Economic Research, Massachusetts
Sharma RH, Shakya NM (2006) Hydrological changes and its impact on water resources of Bagmati watershed, Nepal. J Hydrol 327(3–4):315–322
Subedi BP (2003) Population and environment: a situation analysis of populaiton, cultivated land and basic crop production in Nepal 2001. In: Population monograph of Nepal, vol II. Central Bureau of Statistics, Kathmandu, pp 1–35
Thapa S, Joshi GR (2010) A Ricardian analysis of the climate change impact on Nepalese agriculture. http://mpra.ub.uni-muenchen.de/29785/. Accessed 29 May 2011
USEPA (2011) Agriculture and food supply. U.S. Environmental Protection Agency. http://www.epa.gov/climatechange/effects/agriculture.html. Accessed 12 May 2011
WB (2011) NPL_Country_MetaData. The World Bank (WB). http://data.worldbank.org/country/nepal. Accessed 1 June 2011
WICCI (2009) Agriculture working group. http://www.wicci.wisc.edu/agriculture-working-group.php. Accessed 2 June 2011

Chapter 4
Adoption of Improved Rice Varieties in the Tarai Region of Nepal

Narayan Prasad Khanal and Keshav Lall Maharjan

Abstract Rice is the most important cereal crop of Nepal from the perspectives of food security and livelihood. In spite of this, its yield is quite low and there is still wide gap between potential and national average rice yields. One of the reasons for this is poor adoption of improved rice varieties in farming communities. In this chapter, we analyzed the status of improved rice varieties adoption, sources of improved rice varieties in the farming communities, and influence of socio-economic variables on the adoption of improved rice varieties. The data for the study was collected from 180 households covering three Tarai districts, Siraha, Chitwan and Kailali, of Nepal from October to November 2011. A binary logistic regression was employed to analyze the data, and the adoption of improved varieties was defined from the perspective of whether farmers buy seed from the market or not. The result shows that, in 72.7 % of cases, farmers adopt improved varieties, and these varieties consist of both modern varieties and farmers' varieties. Farmers buy these varieties from various sources though neighboring farmers and agrovet are the most popular sources. Farmers' behavior in adopting these varieties is mainly explained by irrigation facility, household's membership in community-based organizations, and seed price.

Keywords Binary logistic model • Food security • Improved rice varieties • Nepal

4.1 Introduction

Rice (*Oryza sativa* L.) is the most important cereal crop of Nepal in terms of food security and livelihood perspectives. This crop contributes 51 % of the major food crops' (rice, wheat, maize, millet and barley) production, and it supplies 40 % of the

N.P. Khanal (✉) • K.L. Maharjan
Graduate School for International Development and Cooperation, Hiroshima University, Hiroshima, Japan
e-mail: narayankhanal36@gmail.com

K.L. Maharjan (ed.), *Communities and Livelihood Strategies in Developing Countries*,
DOI 10.1007/978-4-431-54774-7_4, © Springer Japan 2014

calorie, and 20 % of protein supplied in Nepalese diet from plant products. Moreover, rice share of agriculture gross domestic product is 20 % and over 70 % of the Nepalese people are engaged in agriculture activities including rice (MoAC 2011). Rice is grown from Tarai (from 70 m amsl) to Mountain (up to 3,050 m amsl—the highest rice growing altitude in the world) regions in Nepal (Paudel 2011). In 2011, this crop was grown in 1.49 million ha, 69.6 % of which is represented by the Tarai region (up to 610 m amsl) alone, constituting 72.1 % of the total rice production in the country (MoAC 2011; FAOSTAT 2012). In that year, average rice yield in Nepal was 2.9 t ha^{-1}, and this figure is quite lower than the average rice yield of China (6.6 t ha^{-1}), India (3.5 t ha^{-1}), Bangladesh (4.4 t ha^{-1}) and world average (4.2 t ha^{-1}). Moreover, the rice yield growth rate in Nepal is lower than that of the above-mentioned countries in the last 50 years i.e. from 1961 to 2011 (FAOSTAT 2012). The rice yield growth rate in Nepal remained below population growth rate during this period, and it could be one of the reasons for increased importation of food grains including rice in Nepal from foreign countries since 1980. Nepal imported 524,592 tons of rice valued at US$ 164.3 million during the period of 10 months (January–October) in 2012. Also, a rice demand/supply scenario projected based on population growth and cereal production data from 1980 to 2010 shows that there could be 19 % deficit of rice in the country to fulfill the domestic demand in 2030 (FAO 2013).

Increased farmers' access to quality (genetic and physical purity) seeds of different varieties is considered one of the most important strategies to contribute in yield growth of this crop. It is because quality seed enhances the efficiency of inputs, and the varietal diversity minimizes risk of crop failure due to diseases, climate, and so on. In Nepal, rice research program was started in 1960, and by 2010, this country has released over 60 rice varieties. It is estimated that these varieties have covered 90 % of the total rice area (NARC 2011). But there is a wide gap (50 %) between the potential and average rice yield. One of the reasons for this yield gap is poor access of improved seed (early generation seed) in rural areas (MoAC 2011). It is evident from poor seed replacement rate (SRR—the ratio of total seed supplied in the country against the total seed requirement).[1] The government statistics show that SRR of rice in Nepal in 2010 was 8.7 % which is far below the recommendation made for self-pollinated crops (25 %) (SQCC 2011). The low SRR means that farmers do not frequently change fresh (early generation) rice seed, and it is more likely that older generation seed is susceptible to diseases which reduce crop yield. In spite of the poor SRR, limited studies have been published analyzing the reasons behind it (Joshi and Bauer 2006; Paudel 2011; Kafle et al. 2012). Moreover, available studies only focus on modern varieties (those developed by agricultural research organizations) neglecting the varieties being developed through farmers' own innovations (farmers' varieties). Moreover, in these studies, farmers were categorized as adopters if they had been able to spell the name of the varieties they were growing regardless of the generations of seed they used. But it is unlikely to get the precise result of rice varieties adoption just asking the name of the varieties

[1] SRR is the proportion of seed supplied in the area with reference to the total seed required

to the farmers considering their poor education, handling of diversified rice varieties, and flow of seed mainly through informal channels. In this chapter we analyze the types of improved rice varieties grown by farmers, sources of these varieties, and farmers' behavior in buying seeds of these varieties from the market. A market-based approach, i.e., whether farmers buy seed from the market or not was employed while analyzing farmers' behavior in buying seed from the market.

4.2 Conceptual Framework

Agricultural scientists consider 'improved rice varieties' as modern rice varieties, and 'improved rice seed' as seeds of modern rice varieties with quality parameters such as germination percentage and purity. The quality parameters are defined by government agencies of any particular country (Almekinders et al. 1994). However, the concept of defining improved varieties by scientists might be different from those of farmers. Farmers might not care who developed what varieties but their concerns would be more about economic benefits they intend to get while adopting the varieties (Joshi et al. 2001; Gauchan et al. 2005; Joshi and Bauer 2006). Farmers could realize economic benefit from rice farming in various ways. For example, improved seeds enhance crop yield and/or byproduct; some rice varieties, especially early maturing ones, might not be profitable to the farmers in terms of their yield or byproducts directly, but growing these crops allows farmers for the cultivation of other crops like vegetables during the cropping season thereby improving cropping intensity and maximizing overall benefits to farmers. Farmers, as profit maximizers, intend to remain efficient in the production process even after taking account external factors such as market, price and weather. To do this, appropriate crop varieties and technologies should be continually introduced for farmers to use in crop production. Also, it is quite complex to segregate whether farmers buy new varieties or buy seeds of the early generation seeds of the existing varieties. Household's decision to buy seeds is difficult to model because it does not depend on the direct benefits alone but also the indirect motivation that prompt farmers to buy seeds. It would therefore be more advantageous to analyze farmers' behavior from the perspective that they firstly develop perception about a variety based on its potential benefits/cost before finally deciding to adopt it in the cropping system. This idea is in line with Rogers' (1995) diffusion theory which explains that adopters go through the five stages (awareness, persuasion, decision to adopt/test, implementation and feedback) in the adoption/diffusion process and develop perception towards the varieties. The perception is influenced by various factors including demographic, economic, social and institutional processes (Gauchan et al. 2005; Joshi and Bauer 2006; Tiwari et al. 2008). This concept addresses the farmers' motivation to buy both modern and farmers' varieties as improved rice varieties are defined from the perspective of whether farmers buy these varieties from the market or not (Paudel and Matsuoka 2008). Also, this concept minimizes confusion among the readers whether farmers buy seeds of new varieties or improved seeds of existing varieties because it is quite complex to separate these two elements in the analysis.

4.3 Methodology

4.3.1 Study Area

The study was carried out in Siraha, Chitwan and Kailali districts of Nepal representing Eastern, Central and Far-western development regions (Fig. 4.1). Rice is the major food crop in these districts which is grown as a main season crop during rainy season (planting in June/July and harvesting in October/November). In 2009/2010, this crop was grown in 63,000, 29,605 and 58,500 ha with yield level of 1.7, 2.8 and 2.5 t ha^{-1} in Siraha, Chitwan and Kailali, respectively. Chitwan district is centrally located with better infrastructure in terms of road network, irrigation facilities as well as outlets for agricultural extension services compared to other two districts. There is increasing trend of monsoon rainfall in this district. In contrast to this, Siraha is drought prone district whereas Kailali is flood-prone district. It is hypothesized that the selection of these districts for this study is representative of the whole Tarai region of Nepal. The surveyed Village Development Committees (VDCs) in the selected districts include: Jagatpur, Mangalpur, Gitanagar, and Birendranagar municipality (Chitwan district); Hakpada, Sisbani, Mahadevparoha and Betauna (Siraha); and Gardaiya, Joshipur, Durgauli and Udasipur (Kailali). The location of these VDCs is also shown in Fig. 4.2.

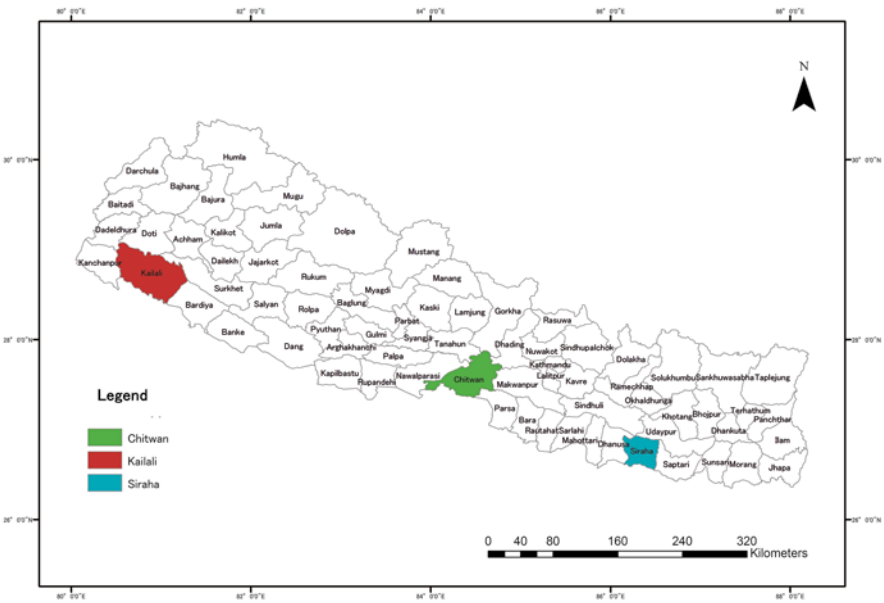


Fig. 4.1 Map of Nepal showing studied districts. *Source*: Raw data from ICCIMOD.org

Fig. 4.2 The maps of surveyed VDCs of the selected districts. *Source*: Raw data from ICCIMOD. org

4.3.2 Sampling Technique

The study uses multistage random sampling technique in selecting the study households. The districts were selected purposively to represent the geographical coverage. In each district, four VDCs were selected considering the non-existence of commercial seed production program. One ward (out of nine wards) from each VDC was randomly selected for the study. After selecting the ward, 15 households were randomly selected for household survey using the list of rice growing households inhabiting in the ward. So, the total number of farmers (respondents) for household survey was 180. The survey was carried out using semi-structured questionnaire tested in the households not involved in the survey. One group discussion in each ward was organized after the completion of household survey to complement the information gathered through the household survey.

4.3.3 Empirical Model

In this study, we used binary logistic model (BLM) to examine the influence of socio-economic variables on the adoption of improved rice varieties. Since the dependent variable takes the value of 1 if farmers buy rice seed from the market and 0 for otherwise, binary logistic model is quite suitable for the analysis. If Ordinary Least Square (OLS) is used to estimate this type of model, it will violate certain assumptions of classical regression. These include non-normality and heteroskedastic error, and questionable R^2 as a measure of goodness of fit (Gujarati 2004). Logit and probit models have been developed to address these issues (Long and Freese 2006). Logit model is adopted in this study, and previous researchers (Joshi and Bauer 2006; Paudel and Matsuoka 2008) have also adopted BLM to analyze the adoption of improved varieties. Theoretically, the BLM is specified in Eq. (4.1) (Agresti 1996).

$$\ln\left(P_X / \left(1 - P_X\right)\right) = \beta_0 + \beta_1 X_{1i} + \beta_2 X_{2i} + \cdots \beta_K X_{Ki} \tag{4.1}$$

Where, ln is log, $_i$ is the ith observation in the sample, P_x is the probability of farmers buying seed from the market in consideration of the given explanatory variables (X_i) and ($1-P_x$) is the probability of non-adoption. β_0 is the coefficient of intercept and $\beta_1, \beta_2 \ldots \beta_K$ are parameters to be estimated, and K indicates the types of explanatory variables. Since the binary logistic model is estimated through maximum likelihood method, the coefficients of the model do not show the average response of independent variables on probability of adopting improved varieties. So, we estimated marginal effect[2] of independent variables on the probability of adopting improved rice varieties after estimating the binary logistic model (Sheikh et al. 2003). The marginal effect values are used to discuss the influence of explanatory variables in the probability of adopting improved rice varieties.

4.3.4 Specification of the Model and Variables

With reference to the theoretical model given in Eq. (4.1), the model used in the study is specified in Eq. (4.2).

$$\begin{aligned} Y = {} & \beta_0 + \beta_1 \ln \text{age of } HHH + \beta_2 \ln \text{education of } HHH + \beta_3 \ln \text{family labor} \\ & + \beta_4 \ln \text{off farm income} + \beta_5 \ln \text{operational land} + \beta_6 \ln \text{livestock} \\ & + \beta_7 \ln \text{chemical fertilizer} + \beta_8 \text{ irrigation dummy} \\ & + \beta_9 \text{ CBO dummy } \beta_{10} + \ln \text{seed price} + \text{Chitwan dummy} + \varepsilon \end{aligned} \tag{4.2}$$

Here, Y represents the binary dependent variable (0, 1) indicating whether a farmer adopts an improved variety or not, ln is the logarithm, β is the parameter to be estimated, ε is the error term. We selected explanatory variables taking into consideration adoption theory, previous studies and experience from the field. These variables are classified as demographic (age and education of household head—HHH, and family labor), economic (off-farm income, operational land, livestock, chemical fertilizer, irrigation, seed price) and institutional (household's membership in community-based organizations—CBOs). The description of the explanatory variables and their hypothesized influence on adoption of improved rice varieties is summarized in Table 4.1.

Since HHH is the major decision maker at household in Nepal, its characteristics might influence household's decision to adopt improved varieties. It was hypothesized that younger HHH are more likely to adopt improved varieties as compared to their counterparts because they have stronger links with seeds market (Paudel and Matsuoka 2008). We hypothesized that education of HHHs might have positive influence on the decision to adopt because people with higher education tend to have better access to extension services on improved seeds and other production inputs (Joshi and Bauer 2006). In the same vein, educated farmers also have higher

[2] Marginal effect = p(1−p)β, where p—probability of occurring the event, and β is the parameter estimated from the model.

Table 4.1 Socio-economic variables included in binary logistic regression

Variables	Definition	Expected sign
Age of HHH	Age of household head (years)	–
Education of HHH	Formal education of HHH (years of schooling)	+
Family labor	Labor force unit (LFU)[a] at household	+
Off-farm income	Household annual cash income from off-farm sources (NRs)	+
Operational land	Operational land under rice production at household (ha)	+
Livestock	Livestock standard unit (LSU)[b] at household	+
Chemical fertilizer	Total cost of chemical fertilizer (NRs ha^{-1})	+
Irrigation	1 = if farmers' have access to public irrigation facility, 0 for otherwise	+
CBO	1 = if any member of household has membership in farmer group/cooperative, and 0 for otherwise	+
Price	Price of rice seed (NRs kg^{-1})	–
Chitwan	1 = farmers from Chitwan district, and 0 for otherwise	+

[a]LFU is the measurement of labor force, where people from 15–59 years old regardless of their sex were categorized as 1 person = 1 LFU, but in case of children (10–14 years old) and elderly people (>59 years old) 1 person = 0.5 LFU
[b]See footnote 3

potential to analyze the perceived benefits and costs associated with adoption of improved rice varieties than their counterparts. Family labor is an important source of input in subsistence farming and it was hypothesized to have positive influence in the adoption of improved rice varieties. Households with higher family labor might be more motivated towards adoption of improved varieties because they help farmers during periods of critical periods of the cropping season such as planting, weeding, fertilizer application, harvesting and transporting farm produce, which greatly enhances yields of improved varieties (Paudel and Matsuoka 2008; Paudel 2011).

Among the economic variables, we hypothesized positive influence of household's off-farm cash income on adoption decisions. Access to credit is still challenging in the study area as most bank and micro-finance services are located in the cities, and it is difficult to access credit for small farmers in these areas (Pradhan 2009). It was hypothesized that those having access to off-farm income can easily buy necessary inputs for rice production, and carrying out crop husbandry activities on time. Similarly, operational land holding was also considered to have positive influence on adoption of improved varieties as households with larger operational holding have higher risk bearing capacity, and motivation to increase yield by combining other agricultural inputs. It was expected that operational landholding would positively influence households for the adoption of improved rice varieties (Tiwari et al. 2008). Livestock is the integral component of Nepalese farming system, farmers using animal manure on their fields. In this study, we calculated livestock standard unit (LSU[3]) and used as a proxy for the amount of manure applied on the rice

[3] LSU is the aggregates of different types of livestock kept at household in standard unit calculated using the following equivalents; 1 adult buffalo = 1 LSU, I immature buffalo = 0.5 LSU, 1 cow = 0.8 LSU, 1 calf = 0.4 LSU, 1 pig = 0.3 LSU, 1sheep or goat = 0.2 LSU and 1 poultry or pigeon = 0.1 LSU (CBS 2003; Baral 2005).

fields. Livestock was expected to have positive influence on improved rice varieties adoption. In addition to animal manure, farmers use chemical fertilizer, and it was hypothesized that chemical fertilizer could have positively influence on the adoption of improved varieties (Paudel and Matsuoka 2008; Regmi et al. 2009). Similarly, it was hypothesized that access to irrigation facilities can have positive influence on improved rice varieties adoption. The price of rice seed was hypothesized to have negative influence on improved variety adoption in accordance to the microeconomic theory.

Institutional variable included in this study is the household's membership in agricultural groups or cooperatives and these institutions are termed as CBOs in this study. These CBOs are the self-help organizations owned and managed by farmers for their own benefit. Being members of CBOs, farmers intend to access agricultural training and improved varieties as extension policy of government and NGOs is group-oriented in Nepal, and those having membership in CBOs are more likely to access extension services from these agencies, and subsequently it might have positive influence on improved variety adoption (Tiwari et al. 2008). As discussed in the methodology section, Chitwan district has better infrastructure and extension services as compared to the other two districts. These factors would be additional sources of variation in the model and could distort the result. To address this issue, we used Chitwan (location) as a dummy variable while running the model.

As per the regression rule, diagnostic tests were carried out to check the heteroskedasticity and multicollinearity problem in the data. For this, selected explanatory variables were regressed against the dependent binary variable using ordinary least square (OLS) technique. Variation inflation factor (VIF) test was carried out to check multicollinearity among the variables. Since the VIF value for the dependent variables remained below 10 suggesting no problem of multicollinearity. Breusch-Pagan/Cook-Weisberg test carried out to test for the heteroscedasticity and the null hypothesis of heteroscedasticity was strongly rejected (p value below 0.004).

4.4 Results and Discussion

4.4.1 Rice Varieties Grown by Farmers in the Study Area

The study shows that farmers adopt 17 different rice varieties in the study area in the growing season of 2011. These varieties can be divided into modern varieties (58.8 %) and farmers' varieties (41.2 %). Out of the total modern varieties (ten), only 50 % of the varieties (Savitri, Hardinath 1, Ramdhan, Mithila and Radha 4) were released by Nepalese government; whereas, the other four modern varieties (Kanchhi Masuli, Sarju 52, Sona Masuli and Sawa Masuli) are the ones released by Indian government in 1970s, and introduced in Nepal's Tarai districts through informal channel (farmer to farmer contact) due to open boarder system between Nepal and India.

Table 4.2 Household level area (ha) and yield (kg ha^{-1}) of different rice varieties across the districts

Varieties	Area/yield	Chitwan	Siraha	Kailali	Overall
Savitri	Area	0.42 (55)	0.20 (3.3)	0.43 (10)	0.41 (22.7)
	Yield	4,250	3,240	4,160	4,156
Hardinath 1	Area	0.25 (10)	0.21 (10)	0.18 (3.3)	0.21 (7.2)
	Yield	3,879	2,875	3,689	3,298
Ramdhan	Area	0.23 (26.7)	–	0.18 (3.3)	0.23 (10)
	Yield	4,568	–	4,381	4,462
Mithila	Area	–	0.10 (1.6)	0.30 (11.7)	0.28 (4.4)
	Yield	–	2,685	2,732	2,694
Radha 4	Area	0.27 (20)	0.20 (5)	0.71(10)	0.38 (11.7)
	Yield	3,526	2,890	4,263	3,492
Kanchhi Masuli	Area	0.11 (1.6)	0.52 (65)	–	0.52 (22.2)
	Yield	3,548	3,248	–	3,284
Sarju 52	Area	–	–	0.61 (81.6)	0.61 (27.2)
	Yield	–	–	5,281	5,281
Sona Masuli	Area	0.66 (1.6)	0.39 (53.3)	–	0.39 (18.3)
	Yield	4,560	4,060	–	4,160
Sawa Masuli	Area	0.34 (20)	0.83 (3.3)	–	0.41(7.7)
	Yield	4,235	3,685	–	4,167
Gorakhnath (hybrid)	Area	0.25 (16.7)	–	0.18 (3.3)	0.24 (6.7)
	Yield	5,570	–	6,250	5,892
Farmers' variety	Area	0.26 (11.6)	0.23 (31.6)	0.59 (23.3)	0.40 (22.2)
	Yield	3,524	2,546	3,875	3,125
Mean rice area	–	0.58	0.91	0.86	0.78

Source: Survey 2011
Note: values in the parenthesis indicate percent of farmers

Recently (since 2005) farmers in Chitwan and Kailali have started growing hybrid rice variety (Gorakhnath), and agrovet introduced this variety in the study area in partnership with multinational companies. The farmers' varieties grown in the study area are *Bangali Masuli, Bhale Masuli* and *Mala* (in Siraha), *Local Masuli* (in Chitwan), and *Bans Dhan* and *Anadi* (in Kailali). The study also shows that the average yield of farmers' varieties is 3.12 t ha^{-1} whereas the yield of modern varieties released by Nepalese government is 16 % higher than farmers' varieties (3.62 t ha^{-1}). But better cooking quality (e.g. *Anadi*) and adaptation in stress condition (such as drought, e.g Bans Dhan) have made these varieties popular in the study area. Similarly, the modern varieties introduced from India produce 4.22 t ha^{-1} (35.2 % higher yield than farmers' variety), and, the yield of hybrid variety is 5.89 t ha^{-1}. There is also variation in the distribution of improved varieties across the district. For example, Savitri is widely grown in Chitwan (adopters 55 % farmers), Kanchhi Masuli in Siraha (adopters 65 % farmers) and Sarju 52 in Kailali (adopters 81 % farmers) are some of the examples (Table 4.2). The popularity of these varieties in a specific location (district) may be due to their better adaptation in that location, which is often governed by variety and environmental interaction (Rana et al.

Table 4.3 Categories of households growing different rice varieties across the districts

Categories	Chitwan	Siraha	Kailali	Overall
Only one variety	5 (9.8)	10 (22.7)	8 (22.2)	23 (17.6)
Two to three varieties	35 (68.6)	26 (59.1)	20 (55.6)	81 (61.8)
Four or more	11 (21.6)	8 (18.2)	8 (22.2)	27 (20.6)
Total adopters	51	44	36	131

Source: Survey 2011
Note: Figures in the parenthesis indicate percentage of farmers with reference to district total adopters

2007). For example, in case of Chitwan, farmers argue that the main reason for the popularity of Savitri in the district is due to its tolerance to leaf blast and bacterial leaf blight diseases. In case of Siraha, where drought has been a serious concern, Kanchhi Masuli has been popular.

Farmers argue that this variety has better adaptation to drought conditions as compared to modern varieties released by Nepalese government. Similarly, one of the reasons for popularity of Sarju 52 in Kailali is due to its better tolerance to flood as per the farmers' opinion. As shown in Table 4.3, 72.7 % of the sampled households were found to have grown improved rice varieties, but the proportion of households adopting improved rice varieties (against sampled households in the district) is higher in Chitwan (85 %) which is followed by Siraha (73.3 %) and Kailali (60 %).

Similarly, it was found that majority of the farmers (>80 %) grow more than one improved rice varieties in their farms. More specifically, 61.8 % of the farmers grow two to three improved varieties, whereas the farmers' growing single variety and those growing four or more than four varieties are 17.6 % and 20.6 %, respectively. The above finding shows that most of the farmers adopt diversified rice varieties. The practice of diversifying the rice varieties by farmers (specifically on subsistence farming) is also common in the developing countries as variety diversification strategy helps the farmers meet their households needs and minimize the risk of crop failures due to natural calamities or diseases/pests severity (Almekinders et al. 1994; Gauchan et al. 2005). In group discussions, farmers argue that the most important reason for diversification at household level is to enhance the productivity of overall farming system. For example, early maturing varieties such as Radha 4 (maturity 125 days) and Hardinath 1 (maturity 110 days) have been grown by farmers in upland (good drainage) area where they plan to grow winter vegetables (such as cauliflower, potato, radish, leafy vegetables, etc) after harvesting of rice. It makes possible for farmers to produce vegetable 15–30 days earlier while using the early season rice varieties than they do with medium duration varieties. But in wheat growing areas (after harvesting of rice), they choose medium duration rice varieties (maturing from 130–140 days after seed sowing). In general, grain yield and straw yield of medium duration rice varieties is higher than those of early duration varieties (Yadav et al. 2005; NARC 2011).

Table 4.4 Sources of improved rice varieties in the study area

Source of seed	Chitwan	Siraha	Kailali	Overall
Neighboring farmers	40 (78.4)	35 (79.5)	32 (88.8)	107 (81.67)
Local agovet	30 (58.8)	16 (36.3)	19 (52.7)	65 (49.6)
CBSPOs	10(19.6)	12 (27.2)	10 (27.7)	32 (24.4)
Development projects	2 (3.9)	12 (27.2)	11 (30.5)	25 (19.08)
N	51	44	36	131

Source: Survey 2011
Note: Figures in the bracket show the percentage of the total adopters. The percentage of total adopters would be more than 100 because farmers could buy seed from more than one source

4.4.2 Sources of Varieties

The study shows that farmers buy seed from four sources: neighboring farmers (81.67 %), local agrovet (49.6 %), CBSPOs (24.4 %) and development projects (19.08 %) implemented by government and NGOs. It means farmers buy seed from multiple sources though neighboring farmers is the most important source. The agrovet buys seed from CBSPOs (of all the varieties except hybrid varieties) and sell to farmers using different packaging sizes (1, 5, and 30 kg). Though being the residence of nearby VDCs from CBSPOs, less than one third of the farmers visit CBSPOs to buy seed (Table 4.4). It was found that development projects still play vital role in supplying improved rice varieties in Siraha and Kailali districts. These projects buy seed from CBSPOs or agrovets to distribute to the farmers (who grow rice as grain), and they give preference to the varieties released by the Nepalese government.

4.4.3 Farmers Behavior in Adopting Rice Varieties

Summary of Study Variables

Table 4.5 shows the summary statistics of socio-economic variables of the households included in binary logistics model with reference to their mean and standard deviation. The data show that average age of household head (HHH) is 41.9 years but it varies among the households. Only 96 % of the HHHs have attended formal schooling and their average formal schooling years was 5.2. The average labor force at household is 3.2, but varieties from 2 to 15.

Average operational holding of 0.78 ha (range 0.06–4.67 ha) which is similar to the national average (0.8 ha). People in the study area make their livelihoods both from on-farm (agriculture) and non-farm (business, salaried job, remittance) activities. Annual average cash income of the households is NRs 59,922. Only 63.3 % of the households get cash income from agriculture, whereas 66.67 % of households receive

Table 4.5 Summary of socio-economic variables included in binary logistic model

Variables	Overall mean	Chitwan	Siraha	Kailali
Age of HHH (years)	41.9 ± 13.64[a]	49.28 ± 13.48	42.03 ± 12.50	34.34 ± 10.63
Education of HHH (years)	5.20 ± 1.58	60.6 ± 6.61	4.81 ± 5.42	4.08 ± 5.12
Family labor (LFU)	3.2 ± 8.76	3.6 ± 2.10	3.10 ± 2.32	2.80 ± 0.78
Off-farm income (NRs)	49,531 ± 67,890	68,640 ± 42,580	48,875 ± 32,256	37,815 ± 20,452
Operational land (ha)	0.78 ± 0.66	0.58 ± 0.45	0.86 ± 0.66	0.91 ± 0.78
Livestock (LSU)	3.46 ± 1.85	5.06 ± 3.56	1.49 ± 0.48	2.85 ± 1.45
Chemical fertilizer (NRs ha^{-1})	5,244 ± 1,245	3,594 ± 1,721	5,530 ± 1,493	6,654 ± 3,298
Irrigation	0.34 ± 0.47	0.39 ± 0.49	0.36 ± 0.48	0.26 ± 0.44
CBO	0.56 ± 0.23	0.68 ± 0.24	0.48 ± 0.21	0.51 ± 0.34
Seed price (NRs kg^{-1})	20.5 ± 16.7	21.3 ± 10.8	20.8 ± 14.21	19.4 ± 8.79
Chitwan	0.33			
N	180	60	60	60

Source: Survey 2011

[a]Standard deviation, 1 US$ = NRs 82.96

cash income from non-farm sources. The average non-farm income of households is NRs 49,531 and it varies from NRs 4,780 to NRs 122,600. Livestock is the integral part of farming system in the study area. All the households were found to have raised livestock, and average LSU in the study area is 3.46 but it varies from 0.5 to 201. Cow, buffalo, goat, poultry and pig are the major livestock species being raised by farmers.

In addition to animal manure, 90 % of farmers apply chemical fertilizers in rice field. The sources of chemical fertilizers are urea (nitrogenous fertilizer having 60 % N), Diamonium Phosphate (18 % N and 48 % P) and Muriate of Potash (60 % K). It was found that the amount of chemical fertilizers applied by farmers in rice field is N:P:K (44.9:25:20.9 kg ha^{-1}) and this doze is smaller than the recommendation made for irrigated rice in Tarai region of Nepal of 100:30:30 kg ha^{-1} (MoAC 2011). We used chemical fertilizer cost (NRs) in the binary logistic regression to represent the amount of chemical fertilizer applied in rice field. On average, farmers apply chemical fertilizer with the cost of NRs 5,244 ha^{-1} and it varies from NRs 0–NRs 10,500. Sampled households use irrigation in their rice field both from public irrigation source (such as canal from river/stream) and /or from private irrigation source (tube well). But only 34 % of the households have access to public irrigation source. Similarly, 56 % of the households have membership in CBOs. Average price of rice seed in the study area is 20.5 rupees, although, there is some variation across households.

Result of Binary Logistic Model

The significant log likelihood statistic shows that the variables chosen for the study fit the model well (Table 4.6). It means the model rejected the null hypothesis that coefficients of the model are significantly different from zero ($p = 0.0001$). Moreover, the percentage correctly predicted from the model is also high (74.5 %). These results show

Table 4.6 Summary of the results from binary logistic regression

Variables	β	P value	Marginal effect[a]	Odd ratio
Age of HHH	0.031	0.184	0.0041	1.31
Education of HHH	0.112	0.121	0.013	1.06
Labor force at household	−0.043	0.165	0.117	0.46
Annual off-farm income	−0.0031	0.243	0.0001	0.37
Operational land	0.811	0.124	0.140	0.68
Livestock	0.0027	0.943	0.0003	0.41
Chemical fertilizer	0.0002	0.705	0.0002	0.55
Irrigation dummy	0.812	0.03***	0.301	3.45
CBO dummy	0.641	0.079*	0.127	2.85
Price of seed	−0.240	0.0127**	0.014	2.14
Chitwan dummy	0.221	0.014**	0.125	2.35
Constant	−2.184	0.012		
Log likelihood: 85.37**, N = 107, Percentage correctly predicted: 74.5, Pseudo R^2: 0.22				

Note: *, ** and ***indicate significance at 10 %, 5 % and 1 % levels, respectively
[a]See footnote 2

the goodness of fit of the model. The study shows that the coefficients of most of the independent variables are as hypothesized; however, the influence of age of HHH, family labor and non-farm income is opposite of what we had expected. Among the explanatory variables, irrigation, households' membership in CBOs, seed price and location have significant influence on households' decision to adopt improved varieties.

Rice is water loving crop and may require additional moisture from irrigation facilities as compared to other cereal crops. However, the number of irrigation varies with type of rice varieties (short duration vs. long duration) and land (upland vs. low land). Farmers are motivated to access irrigation facilities in order to increasing yield from the adoption of these improved varieties (Nkonya and Norman 1997; Paudel and Matsuoka 2008) or cropping intensity (Nkonya and Norman 1997). It means farmers could increase the number of crops in a year by selecting the shorter duration rice varieties (though yield of the variety might not be higher than the existing one) (Fig. 4.3). In addition to canal irrigation (from river), there is a potential to use underground water through tube well but less than 5 % of the farmers use tube well; however, the reasons behind it is not well understood.

In this study, households' membership to CBOs is a proxy variable to represent their access to extension facility (e.g. agricultural training) from government and non-government organizations. The significant coefficient and high marginal effect signifies the influence of CBO membership on the adoption of improved rice varieties. As shown in Table 4.6, the marginal effect of households' having membership in CBOs is 0.127 which indicates that households having membership in CBOs have 12.7 % higher probability of adopting improved varieties as compared to the non-members. This finding is consistent with other previous studies (Paudel and Matsuoka 2008; Tiwari et al. 2008). The reason behind the higher probability of improved rice varieties adoption by CBOs members might be due to their better linkage with the extension agencies (DFID 2010). In the group discussions, farmers opined that as a member of CBO they have to participate in the monthly meeting

Fig. 4.3 Farmer's observing the performance of short duration rice variety

Fig. 4.4 Group members comparing the performance of rice varieties in demonstration plot

and observation of new variety demonstration plots (Fig. 4.4). They also discuss about the problems, lessons and potentials of the new crop varieties/technologies in monthly meetings. All these factors might have influenced adoption decisions.

This study also shows that the price of seed also plays significant role in household's decision to adopt improved rice varieties. It means households experiencing higher seed price are less likely to adopt improved rice varieties and vice versa. Previous studies have shown that farmers normally compare the price of seed with grain of the same commodity in case of self-pollinated crops and if the price of seed

goes up they tend to use household saved seed (Almekinders et al. 1994). David (2004) also found same result in bean production among African countries.

As hypothesized, we found that Chitwan district has significant positive influence on the adoption of improved rice varieties. It might be due to the variation of other variables not considered in this model such as better road network and extension facility in Chitwan as compared to other two districts.

4.5 Conclusion and Policy Implication

In this study, we analyzed the types of improved rice varieties grown by farmers, sources of these varieties, and impacts of socio-economic variables on the adoption of improved rice varieties using binary logistic model. The adopters in the study were defined based on whether farmers buy seed from the market or not regardless of being modern or farmers' varieties. The study shows that, in 72.7 % of the cases, farmers adopt improved rice varieties, consisting of both modern and farmers varieties. Farmers buy these varieties from various sources with neighboring farmers and agrovet are the major sources. The results of binary logistic regression show that the adoption of improved rice varieties is mainly influenced by irrigation, household membership in CBOs, and seed price. This implies that the existing extension agencies should integrate these strategies in improved varieties promotional program. For example, focusing improved varieties in irrigated area might have large impact. This does not mean that improved variety should be promoted only in irrigated areas. Drought tolerant varieties could be promoted in rain-fed areas and farmers could increase rice yield. Similarly, we found significantly positive influence of households' membership in CBOs but still about half of the households are not engaged in CBOs. This implies that the extension agencies of both government and NGOs should encourage farmers to join CBOs so that they could access extension services in agriculture and this could have positive influence on improved varieties adoption in rice. Moreover, this study shows that households experiencing higher price of seed are less likely to adopt improved varieties. It means that emphasis should be placed on rice seed production at local level so that cost of production and transportation could be reduced thereby enhancing accessibility of cheaper rice seeds by farmers.

References

Agresti A (1996) An introduction to categorical data analysis. Wiley, USA

Almekinders C, Louwaars NP, Bruijin GH (1994) Local seed system and their importance for an improved seed supply in developing countries. Euphytica 78:207–216

Baral N (2005) Resource use and conservation attitude of local people in the western tarai landscape, Nepal. Unpublished master thesis, Florida International University, Florida

CBS (2003) National sample census of agriculture Nepal, 2001/02; Highlights, Kathmandu, Nepal, National Planning Commission Secretariat, Central Bureau of Statistics

David S (2004) Farmer seed enterprises: a sustainable approach to seed delivery? Agric Human Values 21:387–397

DFID (2010) Uptake of new rice varieties in India. The impact assessment report. Department for International Development, Kathmandu

FAO (2013) Crop situation update: a joint mission of 2012 summer crops and outlook of 2012/13 winter crops. Nepal Food Security Monitoring System. https://sites.google.com/site/nefoodsec/home/crop-situation-update. Accessed 10 Jan 2013

FAOSTAT (2012) Crop information 2011. Food and Agriculture Organization of United Nation. http://faostat.fao.org/site/567/DesktopDefault.aspx?PageID=567#ancor. Accessed 11 Feb 2013

Gauchan DM, Smale M, Chaudhary P (2005) Market-based incentive for conserving diversity on-farm: the case of rice landraces in central tarai, Nepal. Genet Res Crop Evol 52:293–303

Gujarati DN (2004) Basic econometrics, 4th edn. Tata McGraw-Hill Publishing Company Limited, New Delhi

Joshi KD, Sthapit B, Witcombe JR (2001) How narrowly adopted the products of decentralized breeding? The spread of rice varieties from a participatory plant breeding program in Nepal. Euphytica 122:589–597

Joshi G, Bauer S (2006) Farmers' choice of modern rice varieties in the rainfed ecosystem of Nepal. J Agric Rural Dev Trop Subtropics 107(2):129–138

Kafle B, Paudel MN, Ghimire RC (2012) Assessing current status of rice varieties in river basin area of Nepal: concern for diffusion. Int J Agric Res Rev 2(2):59–61 Electronic Center for International Scientific Information. http://www.ecisi.com. Accessed 10 July 2012

Long ST, Freese J (2006) Regression model for categorical dependent variables using stata. A Stata Press Publication, Collage Station

MoAC (2011) Statistical information on Nepalese agriculture. Agri-Business Promotion and Statistical Division, Kathmandu

NARC (2011) Released and registered crop varieties in Nepal (1960–2010). Nepal Agriculture Research Council. http://narc.gov.np/publicaton/pdf/varieties_released/Recorded%20released%20varieties.pdf. Accessed 15 July 2012

Nkonya E, Norman D (1997) Factors affecting adoption of improved maize in Northern Tanzania. Wiley Online Library. http://onlinelibrary.wiley.com/doi/10.1111/j.1477-9552.1997.tb01126.x/pdf. Accessed 30 Aug 2012

Paudel MN (2011) Rice (*Oryza sativa* L) cultivation in the highest elevation in the world. Agron J Nepal 2:31–41

Paudel P, Matsuoka A (2008) Factors influencing adoption of improved maize varieties in Nepal: a case study from Chitwan district. Australian J Basic Appl Sci 2(4):823–834

Pradhan KK (2009) Rural finance in Nepal: prospective from cooperative sector. Cooperative Development Board, Kathmandu, Nepal. Sahakari Sambad Ann Bull

Rana RB, Garforth C, Stapit B, Jarvis D (2007) Influence of socio-economic and cultural factors in rice variety diversity management on-farm in Nepal. Agric Human Values 24:461–472

Regmi A, Tripathi G, Giri S, Bhatta M, Sherchan DP, Karki KB, Kumar, V, Ladha, JK (2009) Improving food security through integrated crop and resource management in the rice-wheat system in Nepal. International Rice Research Institute. http://irri.org/knowledge/publications/irri-books/integrated-crop-and-resource-management-in-the-rice-wheat-system-of-south-asia. Accessed 25 Sept 2011

Rogers EM (1995) The diffusion of innovations, 4th edn. The Free Press, New York

Sheikh AD, Rehman T, Yates CM (2003) Logit models for identifying the factors that influence the uptake of new technologies by farmers in the rice-wheat and the cotton-wheat farming systems of Pakistan's Punjab. Agr Syst 75:79–95

SQCC (2011) Annual report. Seed Quality Control Center, Ministry of Agriculture and Cooperative, Kathmandu

Tiwari KR, Sitaula BK, Nyborg ILP, Paudel GS (2008) Determinants of farmers' adoption of improved soil conservation technologies in mid mountain watershed of central Nepal. Environ Manage 42:210–222

Yadav RB, Chaudhary B, Adhikari NP, Akhtar T (2005) Hardinath 1, an early maturing rice genotype released in Nepal. http://dspace.irri.org:8080/dspace/bitstream/123456789/1144/1/Yadaw,%20R.%20B.%20Hardinath%201,%20an%20early.pdf. Accessed 11 July 2012

Chapter 5
Effects of Environmental Factors on Cattle Milk Production Among Smallholder Households in Ala-Buka, Kyrgyzstan

Munavar Zhumanova, Zakaria Amidu Issahaku, and Keshav Lall Maharjan

Abstract This chapter evaluates milk production in cattle among smallholder households in the BVG, Ala-Buka, Kyrgyzstan. The effect of calving seasons on the shape of the lactation curve is first analyzed. Initially, milk yield increases, and the slowly decreases after peak milk yield in winter and autumn. Generally, peak milk yield and lactation persistence serve as the criteria for herders in selecting cattle. However, peak milk yield tends to a clearer association with total milk yield and can be used as a useful guide in selecting cattle breeds as opposed to lactation persistence. Peak milk yield is higher in winter and autumn clavers vis-à-vis spring and summer calvers. The effect of calving season is largely dependent on the availability of forage. Forage shortage in spring and early summer, and lack of fodder from the end of winter to mid spring are perceived as the major problems by about half of households in BVG. Forage shortage during spring and summer tends to decrease cattle productivity. The sweltering heat in summer and drought conditions in spring do not also auger well for optimum milk production. The study recommends the manipulation of calving to match periods of forage availability. It also recommends protection of cows from adverse weather conditions to optimize milk production in BVG, Kyrgyzstan.

Keywords Calving seasons • Forage • Kyrgyzstan • Lactation curve • Milk production • Peak milk yield

M. Zhumanova (✉)
Mountain Societies Research Institute, University of Central Asia, Bishkek, Kyrgyzstan
e-mail: munavar.ozh@gmail.com

Z.A. Issahaku
Graduate School of International Development and Cooperation, Hiroshima University, Hiroshima, Japan

Ministry of Finance and Economic Planning, Accra, Ghana

K.L. Maharjan
Graduate School of International Development and Cooperation, Hiroshima University, Hiroshima, Japan

K.L. Maharjan (ed.), *Communities and Livelihood Strategies in Developing Countries*,
DOI 10.1007/978-4-431-54774-7_5, © Springer Japan 2014

5.1 Introduction

Smallholder dairy farming in Kyrgyzstan contributes to improved household food security and incomes. Local indigenous and crossbreeds such as, Ala-Too and Oluya-Ata, are raised because of their ability to survive in harsh climatic condition of Kyrgyzstan and to produce higher amount of milk. Local breed cattle size is small. It is believed that the origin of local breed is from North-western China. The total amount of produced milk during lactation period is less but fat content is higher than other breeds. This breed very well adapts to mountain climate and forage condition (Zhumanova and Maharjan 2012).The meat-dairy direct Ala-Too breed of cattle has been developed in 1950. It is improved crossbred of local cattle with Swiss Brown and Jersey blood and it make-up about 85 % of the total cattle number. This crossbreed can tolerate even the harsh climate condition and geographical landscape. Another local crossbreed is Oluya-Ata dairy direct breed which make-up about 10 % of the cattle in the republic are black and white graded up from Friesian/Holstein imports (Fitzherbert 2005; Nogoev 2008). Currently, quantity of milk produced at district and national levels in Kyrgyzstan is still increasing due to the growth in the number of cattle raised. However, milk yield is declining, particularly among smallholder agro-pastoral production systems that are common in most mountainous areas. The declining trend of milk yield is attributable to low level of management skill, insufficient supplementary feeds, diseases and seasonal forage shortages. Selling raw milk and milk products by farmers started after independence of this country from the previous Soviet Union mainly as additional income source for households. However, the majority of them raise cows only for self-consumption of meat as they have the belief that "white thing" cannot be sold and rather give it out free to people who need it or request for it. Considering the importance of dairy cattle on household nutrition and cash income, efforts are underway from research and development agencies to improve the efficiency of farmers in milk production.

Improving efficiency in milk production requires good knowledge of lactation curve, which shows the relationship between milk yield and time after calving. It helps in nutritional and reproductive management of lactating animals (Anwar et al. 2009). The lactation curve can be employed to estimate milk yield, expected time of peak milk production, peak milk yield, and lactation persistence, which are useful for managers of dairy farms in culling low milk producers in planning for feed and farm resources (Wood 1967). Variations in the shape of the lactation curve for dairy cattle are believed to stem from both genetic and environmental factors (Wood 1969, 1970a, b, 1980). The environmental factors are the combination of management as well as climatic factors. Researchers have been using different empirical model to discuss the relationship of these factors on lactation curve. Olori et al. (1999) fitted data obtained from a single uniformly managed herd to five different models, none of which adequately described individual lactations. They inferred that the suitability of empirical models of the lactation curve does not depend on its functional form alone but also biological nature of the lactation. Seasonal patterns in pasture availability, for instance, are major environmental factors contributing to

typical lactations that cannot be adequately described by standard models (Kamidi 2005). Similarly, Wright and Duncan (2005) found that management of herd size, fodder and pasture resources, and off-farm resources as well as grazing and management tradition, could be important factors influencing lactation. These management factors improve the efficiency of livestock production (generating higher livestock products from fewer numbers of livestock).

Information on the shape of lactation curves in indigenous and crossbreed cows of Kyrgyzstan is very limited. There are few studies about mathematic modeling of lactation curves for smallholders in agro-pastoral systems. Most of the studies conducted on mathematical modeling of lactation curve are on large-scale dairy farms with well-organized farming systems (Rook et al. 1993; Dijkstra et al. 1997; Pollot 2000, 2004). Unlike those studies, this chapter aim to apply Wood's Gamma model in analyzing the shape of the lactation curve among lactating cows in smallholder farms with different agro-pastoral management systems of indigenous and local crossbreeds in Kyrgyzstan.

5.2 Material and Methods

5.2.1 Study Area

This study was conducted in Ala-Buka district, Jalal-Abad region in the south western part of Kyrgyzstan. There are eight Local Administrative areas in Ala-Buka district and Baltagulov Village Government (BVG) was selected for this study. During Soviet period, BVG had one of the largest sovkhozes (state-owned farms), specialized in breeding meat-dairy direct local crossbreed cattle, Ala-Too. Sufficient irrigation from ground water sources has made crop cultivation together with livestock rearing the main source of livelihood in BVG. Currently; most of the smallholders (67 % of 120 sampled households) keep 1–2 Ala-Too crossbred cattle and its annual milk production ranges between 1,000 and 3,500 kg in this area. Other households, who live in remote mountainous area, prefer to keep local breed. The total milk yield of local breeds ranges from 500 to 1,000 kg annually. Usually, lactating cows in the study area are fed under all year round open grazing, seasonal grazing and zero grazing (stall feeding) systems.

5.2.2 Grazing Systems

All Year Round Open Grazing System

There are few households, who move to pastures under transhumance, use all year round grazing system. Summer pastures are used by minority pastoral households, hired shepherds and large herd owners as part of the open grazing system. To use

remote pastures for grazing, herd should consist of at least 300–500 sheep and goats, 15–40 horses, 20–30 lactating cattle or 100–200 dry cattle. Movement of households to pastures closely depends on income from livestock. The main income of the pastoral households comes from the selling of livestock and its products. Recently, such transhumance pastoral households are declining. Instead, they engage shepherds to look after their animals for transhumance grazing. Hence, hired shepherds have increased in rural areas. About five hired shepherds randomly collect livestock from their own and from other villages and even other districts to make the herd size good enough for grazing. Collected herds are divided to less labour required and more labour required; randomly collected herd composition depends on pasture topography, distance from the village and purposed livestock product types (milk products: horse and cow) and physiological state (age of animals in case of cattle). On the other hand, before the collecting animals, hired shepherds should bargain the grazing payment for each livestock species with elders of the village. They will make oral contract and some elders will be guarantor for hired shepherds, to control payments. And also those elders make negotiation between farmers and shepherds about payment for lost animals (some animals die due to different reasons or become sick or get stolen from summer pastures and so on). Herding costs in such case vary among species; For example, in case of sheep, the cost in the early months is 70 som[1] per sheep which is reduced to 50 som per sheep in the late months. The figures for goat and cattle are 250 som and 300 som, respectively, in the early months, and 200 som and 250 som, respectively, in the late months. Higher payment for the first month is due to poor growth, high mortality risk, less grass in pastures (too early movement) and harsh climate conditions. Sometimes, households can make payments for herding in kind using butter and other products. High herding cost for sending livestock to summer pastures creates difficulties for poorer households. Thus, those households, who own on average 20–25 sheep and goats or 1–2 cattle, are not able to pay for herding (all year round open grazing) and livestock have to remain in near-village pastures under seasonal grazing system near the village.

Seasonal Grazing Systems

Majority of households (47.8 %) use dual feeding: seasonal grazing and stall feeding systems. Dual feeding can be observed in two types: daily and seasonally. During the day time, from April to October, households graze their livestock on pasture near village, and in the evening, they feed livestock with crop residues or weeds mowed from household plot and cropland. Feeding in the morning depends on grass availability in the pastures and livestock classes. For example, in summer, lactating cows are fed in the morning and in the evening (because days are longer). Under seasonal grazing system, livestock are sent to nearby pastures to graze in

[1] 1US$ equals to 46.52 som as of August 2010

spring, summer and autumn, but opt for stall feeding in the wake of the cold weather in winter. About 62 % of households in BVG practise this system, involving mainly lactating cattle and few small ruminants. Payments for herding are also different. Two types of herding are observed: first, *Bada* system (hired 3–4 shepherds and cowboys), from spring to autumn, usually apply to lactating cows, and payment per lactating cow is 100 som per month; second, *Kezuu* system (Turn in rotation) involves households making labor contribution to take care of the animals. The number of persons for the rotation depends on herd size and season, with higher numbers required in spring and autumn, but reduces during summer because of the availability of pasture grasses and damage of cropland. In winter, livestock will be kept under stall feeding. They will be fed with stored forage, collected during the growing season from haylands and croplands, and concentrate. Farmers rarely purchased feed from other farmers and markets. Traditional and modern private livestock management strategies have been developed to regulate herd size, according to the available fodder supplies.

Stall Feeding System

Households, who live in higher settled villages or district centers, use zero grazing (stall feeding) system. Distance from market is important in BVG. Easy access to market and significant high price for dairy products is enough motivation to keep large number of lactating cows. Thus, majority of lactating cows and particularly fattened animals such as castrated male and old animals are kept under the stall feeding for sale and being restocked with younger ones. There are also many popular traditional methods of preparing supplementary feed. *Atala*—boiled feed consists of a mixture of wheat bran, maize flour, sunflower seed residue, salt and water—is usually prepared during winter to feed mostly lactating animals. *Tert*—soaked wheat straw or some woody hays in warm water (20–30 min before feeding) or in cold water (7–10 h) mixed with wheat bran or maize flour—is prepared with maize flour contents which is more nutritious than wheat bran, to feed lactating animals (cows, ewes and goats) during the winter period. *Tokoch* and s*hor tokoch*—salty cake, baked like bread made from a mixture of wheat, maize flour (sometimes barley flour) with salt and water—is usually used to feed mostly lactating cows to increase milk and fat content, and fattening animals to gain live-weight faster.

At household level, farmers use cropland to grow cereals, oil plants, vegetables among others for their home consumption and for supply in the market. Majority of farmers prefer wheat to other crops because of its multiple uses. It can be used for self-consumption and feed for livestock (crop residues such as straw, bran and residue from cleaning of seed) as well as income source from selling of surplus seed and straw. Also, households can freely access to haylands for accumulating and selling roughages.

5.2.3 Analytical Model

The lactation curve technique is often used to estimate lactation yield, expected time of peak milk production, peak milk yield, and lactation persistence. Lactation curve represents a graphical representation of the relationship between milk yield and lactation length, and it is useful for managers of cows in culling low milk producers and in planning for feed and farm resources (Anwar et al. 2009). The functional form of the lactation curve adopted in this study is Wood's gamma function (Wood 1967) as specified in Eq. (5.1).

$$Y = \beta_0 n^{\beta_1} \exp\left(-\beta_2 n\right) \tag{5.1}$$

Where Y is the average monthly milk yield in month n; β_0 is the scale parameter indicating Initial milk Yield; β_1 and β_2 are the shape parameters of the curve, for the increasing and decreasing phases of the lactation curve respectively; and exp is the exponential function. The exponential function is used to model a relationship in which a constant change in the independent variable gives the same proportional change (i.e. percentage increase or decrease) in the dependent variable. The function is often written as exp (x). The gamma model is transformed logarithmically into a linear form for least squares regression analysis as in Eq. (5.2).

$$\ln\left(Y\right) = \ln\left(\beta_0\right) + \beta_1 \ln\left(n\right) - \beta_2 n \tag{5.2}$$

The logarithmic transformation of Y, β_0 and n, are ln(Y), ln(β_0) and ln(n), respectively in Eq. (5.2). Ordinary Least Squares (OLS) estimates of β_0, β_1 and β_2 can be used to calculate time to peak milk production, time to peak production and the persistence of the yield curve. Peak milk yield represents the maximum milk yield during lactation, and the lactation persistency expresses the ability of animals to maintain a reasonably constant milk yield after the lactation peak. Time to peak milk production is calculated by using the ratio of β_1 and β_2 coefficients whereas peak milk yield and persistence of the yield curve are estimated using the following formulas:

$$\text{Peak Milk Yield} = \beta_0 \left(\beta_1 / \beta_2\right)^{\beta 1} \exp\left(-\beta_1\right) \tag{5.3}$$

$$\text{Lactation Persistency Index} = \frac{\text{mean milk yield}}{\text{peak milk yield}} \times 100 \tag{5.4}$$

$$\text{Estimated Total Milk Yield} = \beta_0 \left(\beta_1 + 1\right) / \beta_2^{(\beta_1 + 1)} \tag{5.5}$$

In dairy cattle, milk production typically rises to a peak 2–8 weeks post-partum and steadily declines thereafter (Wood 1969; Kamidi 2005). This study focuses on peak yield, time to peak milk production and persistency in individual lactation curves. The lactation curve, based on the above-mentioned features, is analyzed by season of calving.

Table 5.1 Summary statistics of milk yield (kg/month) of cows by season of calving

	N	Mean	Standard deviation	Minimum	Maximum
Overall	89	156.71	49.26	66.67	309
Season of calving					
Winter	53	169.91	50.1	66.67	309
Spring	26	132.35	34.92	78.4	196.25
Summer	3	112.78	25.24	88.33	138.75
Autumn	7	166.15	58	105.88	268.29

5.2.4 Sampling and Data Description

For this study, 80 households were sampled from different villages of BVG. Data on 89 mixed-breed lactating cows, calving between November 2008 and September 2010, were collected through semi-structured questionnaire. The summary of lactation data by calving season is shown in Table 5.1. The mean monthly milk yield for all cows is 156.26 kg and the standard deviation is 49.26 kg.

Period of calving is categorized into four seasons and they are winter (December–February), spring (March–May), summer (June–August) and autumn (September–November). Most cows considered under this study calved in winter and spring (Table 5.1). Mean monthly milk is higher among cow calving in autumn and winter and lower in spring and summer.

5.3 Results and Discussion

This section presents and discusses the OLS parameter estimates of the Wood's model. From Table 5.2, the overall estimates for initial milk yield (β_0), inclining slope (β_1) and declining slope (β_2) were 175.08, 0.9464 and 0.3174, respectively. All of the parameters of the lactation curve are statistically significant. It takes about 3 months for monthly milk yield to reach its peak at 191.10 kg. Overall, lactating cows have persistence after peak yield of 97.02 % and total milk yield of 3,180.83 kg. The R^2 for the transformed logarithmic gamma function is 27.35 % which shows the goodness of fit of the model.

The estimated lactation curve together with actual lactation curve is shown the Fig. 5.1. Both actual and predicted monthly milk yields increase to reach a peak within few months and, thereafter, decline over several months, which is the defining characteristic of lactation curves. Over the entire duration of lactation, the predicted lactation curve lies below the actual lactation curve, indicating that the predicted milk yield underestimates actual milk yield of all cows considered under this study.

Table 5.2 Parameter estimates of lactation curve and other lactation features by calving season

	β_0	β_1	β_2	Peak yield (kg)	Time to peak (months)	Persistence index (%)	Total milk yield (kg)	R^2 (%)
Overall	175.08*** (1.0396)	0.9464*** (0.0812)	0.3174*** (0.0214)	191.10	2.9817	75.83	3,180.83	27.35
Season of calving								
Winter	188.84*** (1.0517)	0.9660*** (0.1036)	0.3176*** (0.0268)	288.38	3.0416	76.11	3,539.81	27.89
Spring	151.12*** (1.0626)	1.0395*** (0.1290)	0.3524*** (0.0346)	221.54	2.9498	73.68	2,586.22	38.17
Summer	133.14*** (1.1951)	0.9880** (0.4308)	0.3485** (0.1281)	196.24	2.835	73.20	2,151.92	31.10
Autumn	221.89*** (1.1534)	0.8442** (0.3238)	0.3400*** (0.0909)	328.05	2.4829	71.21	2,992.21	31.34

Notes: *** means significant at 1 % and ** means significant at 5 %; values in parenthesis are s the standard errors of regression estimates; peak milk yield and total yield are in kilograms while time to peak production is in months

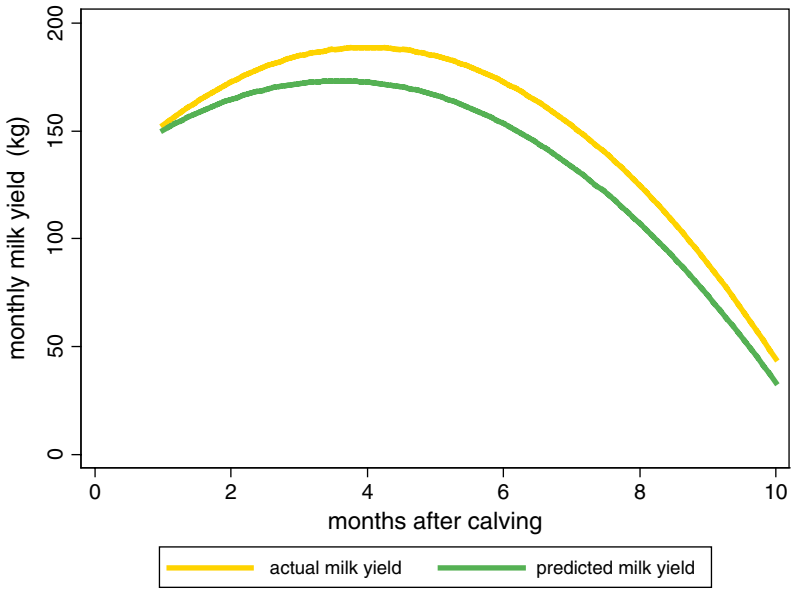


Fig. 5.1 The predicted lactation curve and actual curve

5.3.1 Effect of Calving Seasons

The values of initial milk production (β_0), the inclining coefficient of the lactation curve (β_1) and the declining coefficient (β_2) for all seasons together with their standard errors are presented in Table 5.2. All the parameters of the lactation curve by season of calving are statistically significant at conventional levels. Initial milk yield is higher in autumn and winter as compared to spring and summer. The inclining (β_1) and the declining (β_2) slopes are lower for winter and spring calvers. The R^2 for the transformed gamma function is 27.89 %, 38.17 %, 31.10 % and 31.34 % for winter, spring, summer and autumn, respectively.

Milk production is largely dependent on the shape of the lactation curve. Relevant elements of the lactation pattern are the peak yield and the lactation persistence (Fig. 5.2). Both higher peak milk yield and lactation persistence of peak product tend to raise total milk yield. Higher lactation persistence increases the area under the lactation curve thereby resulted in higher total milk yield. Thus, cows with persistent lactation tend to have flatter lactation curves. Calvers with high initial milk yield also tend to have higher peak milk and higher total milk yield (Table 5.2). Cows calving in winter and autumn have high initial milk and peak milk levels (188.84 and 221.89 kg) as compared to spring and summer calvers. Winter and spring have slightly longer time to peak and strong lactation persistence as compared to summer and autumn. Efficiency of milk yield, in general, requires both high peak milk yield and lactation persistence. Calvers for all seasons have similar peak milk persistence ranging from about 71 % in autumn to 76 % in winter

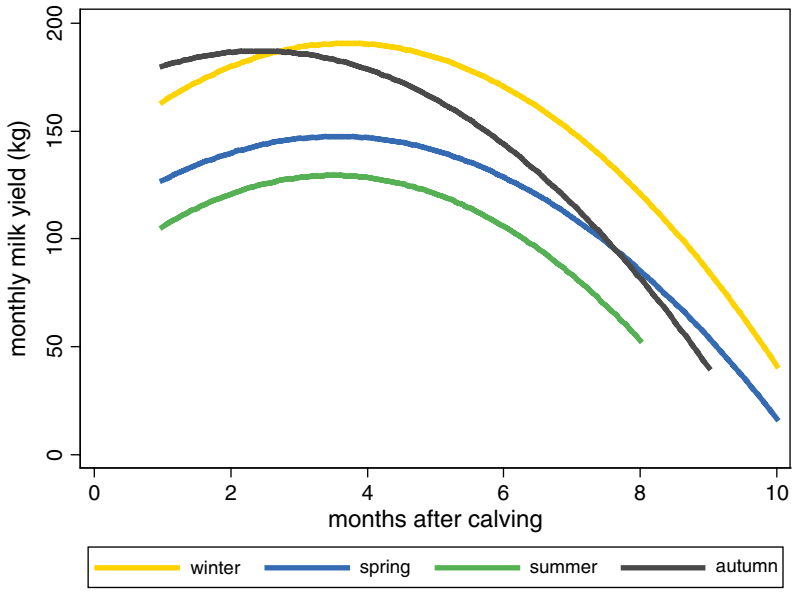


Fig. 5.2 Lactation curves by seasons of calving

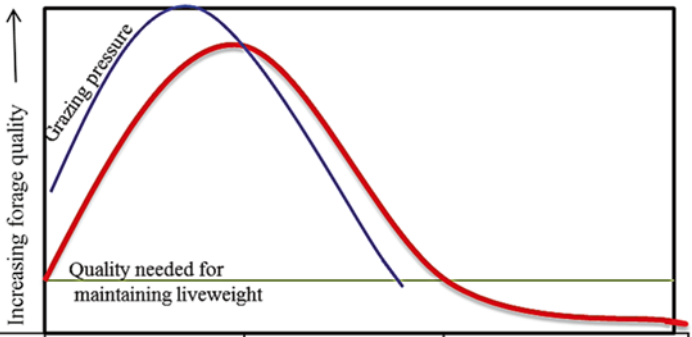
(Table 5.2). Peak milk yield, however, varies markedly across calving seasons. The ranking of peak milk yield tends to determine total milk yield in BVG. Winter and autumn calvers have higher peak yields and therefore higher total milk yield of 3,180.83 and 2,992.21 kg respectively as compared to 2,586.22 and 2,151.92 kg for spring and summer, respectively (Table 5.2).

5.3.2 Forage Availability Situation: Gaps and Priorities

The effect of calving season and total produced milk yield are largely dependent on the availability of forage and pastures, and management practices adopted to protect the animals against adverse climatic conditions. Forage availability and scarcity affect milk yield and made significant change in lactation curves by calving season. Availability of all year round feed, for grazing and for stall feeding, is one of the most important factors in the livestock production.

5.3.3 Grazing (Pasture) Management in All Year Round and Seasonal Grazing Systems

Farmers have to manage pasture such that there will not be shortages in certain times of the year in order to sustain milk production. Pasture shortage is triggered



Climate	Rain, temperature	Temperature	Rain, snow temperature
Growth stage	Germination , new growth	Flowering Maturity	Drying Dry feed
Season	Midspring to midsummer	Summer, autumn	Autumn ,early spring

Fig. 5.3 Forage quality changes according to climate and plant's stage of growth. *Source*: Adapted from Henry et al. (1995)

by weather conditions, early movement to pastures and overgrazing which may alter pasture composition and reduces edible pasture grasses. Changes in pasture condition occur according to timing of rainfall, growth stage of pasture plants, plants type (Grass vs. Forbs) and soil fertility. Plant growth stage is a major factor affecting forage quality (Fig. 5.3).

Forage quality increases rapidly from May to July. As grasses mature after flowering (late July–August), their quality declines due to increasing proportion of less digestible grass. On the other hand, this change has positive effect on the fat content of milk. Grazing management is important in all stages in order to conserve forage species; early movement to pasture decreases number of new growing forage species, overstocking decreases number of flowering species and incessant rainfall and early snowing decrease seeding of plants. Early movement of livestock to pastures without consideration of pasture grass availability has negative impact on vegetation and preliminary degradation of pastures. At this time, the soil is usually soft because of the recently melting snow and early rains. On the other hand, the plants must have an opportunity to produce leaves and strengthen their root systems; otherwise their subsequent growth will be reduced. These create optimal conditions for the growth of non-edible and harmful pasture grasses. It also affects botanical composition of pastures.

Pasture shortage ensues due to lack of pasture land and increase in number of retained livestock during summer in near-village and intensive pastures. The number of retained animals in BVG was very high, 64 % of surveyed households. Due to bad animal performance in early spring, high mortality risk, less grass in pastures (too early movement), harsh climatic conditions and high cost of herding, farmers

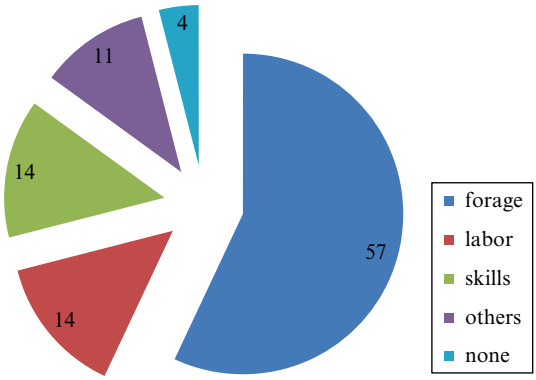


Fig. 5.4 Perception of households on problems of livestock management in BVG. *Source*: Field survey 2010

do not send their livestock to intensive and remote pastures. Especially, high herding cost of sending livestock to summer pastures created difficulties among poorer households; they are not able to pay for herding, and livestock have to feed on near-village pastures in summer. Thus, high numbers of livestock in near-village pastures cause overstocking and pasture shortage and pasture degradation (Fig. 5.4).

5.3.4 Feeds and Feeding Methods in Seasonal Grazing and Stall Feeding Systems

This sub-section explains the feed composition and methods for livestock in BVG, Kyrgyzstan as in Table 5.3. On average, in all households, stored roughage at the end of autumn season includes wheat straw (26 %), maize stover (24 %), Lucerne (20 %), hay (19 %), and other crop stalks (11 %). The types of accumulated roughage in all VGs were generally similar. However the proportions differed in case of wheat straw, Lucerne, crop residues and hay. In BVG, households stored 24 and 13 % more of wheat straw and other crop residues (such as bean, pea), respectively. Hay is one of the major winter roughage. It comes from two sources: natural meadows (community source) and sown and irrigated forage lands (individual farms or farmers). On average, stored feed grains, fed as concentrate and mixed grains include maize (30 %), wheat residue, locally called *chary*, residue after cleaning of wheat seed (13 %), wheat bran, locally called *kevek*, residue after milling of wheat flour (18 %), barley (10 %), cottonseed, locally called *kunjara* (9 %), oil plant residue, seed residue after squeezing of oil (14 %) and concentrate, mixed grain flour (6 %). Maize (36 %) was main grain feed in other VGs, whereas in BVG wheat bran (28 %) was dominant feed type. In all VGs, it was observed that main sources of grains came from wheat, maize and sunflower crop residues, as they are grown as multipurpose crops. Other supplements, such as vitamins, minerals and salt are purchased and they were given to the animals by only 11 % of

Table 5.3 Livestock feed management in BVG

Types of feed	Types of ingredients	Percentage (%) of households		
		BVG	Other VGs	Aggregate
Roughage	Wheat straw	38	14	26
	Maize stover	21	26	24
	Lucerne	11	29	20
	Hay	12	26	19
	Other crops' stalk	18	5	11
Grain feed	Maize	25	36	30
	Wheat residue *(chary)*	17	9	13
	Wheat bran *(kevek)*	28	9	18
	Barley	6	13	10
	Cottonseed	3	15	9
	Oil plant residue	15	13	14
	Concentrate	6	5	6
Feed ration	Maintenance	61	70	65
	Production	34	27	31
	Balanced	5	3	4
Households with surplus and deficit of forage	Surplus	59	21	40.1
	Barely deficit	28	40	34
	Deficit	13	39	51.6
Reduction of livestock feed during feed scarcity period	Cattle (young animals)	40(36)	17	28 (26)
	Sheep and goats	23	53	38
	For other livestock	37	30	34

Source: Field survey 2010

households in BVG, which is lower than other VGs (16 %). Type of feed for livestock depends on household welfare. Only 48 % of households in BVG fed their livestock with whole roughage and grain, because this type of feed requires extra labour, time and payment.

Majority of households in BVG (59 %) perceived that they have enough feed with surplus for overwintering of their herd. The feed surplus is higher among households with small herd sizes. Forage sufficiency decreases as herd sizes increases. Nutritive value of feeds and feeding standards (Metabolized Energy (ME) and Crude Protein (CP) contents) play an important role in feed composition. In all VGs, it was observed that low value and poor quality feeds lead to livestock malnutrition. It was also noted that most households keep their livestock under maintenance ration. This practice is significantly high in all VGs (61 % in BVG and 70 % in other VGs). It implies that keeping livestock by majority of households is not meant to increase livestock products (meat and milk). Deficit of feed forces households to reduce the amount of feed given to livestock. Decrease in feed amount for all animal classes was significantly high in all VGs; in BVG, it is about 37 %. These challenges affect animal performance, derived productivity and household welfare.

Fig. 5.5 Lactating cows grazing on nearby village pastures in summer (*left*) and in winter (*right*) in BVG. *Source*: Field survey 2010 and 2012

5.3.5 *Effect of Forage on the Shape of Lactation Curve and Total Milk Yield Production*

Majority of households in BVG identify forage as the single most important factor in keeping livestock (Fig. 5.3). About 57 % of surveyed households perceive fodder and pasture forage shortage as the biggest problem. The cropping pattern in Kyrgyzstan is such that fodder is more abundant on cropland in autumn but there is an acute shortage during early spring and mid-summer due to dry and hot weather.

The pasture shortage in early spring is attributable largely to early movement to pastures when grasses have not yet matured (Fig. 5.5). Dry and hot weather condition or lack of water during growing season adversely affects quality of forage crops at this time of the year. In the rural areas, households store hay for winter feeding during which time heavy snow occurs. In BVG, moving from the "serious problem" to "no problem" stage takes about 3 months (from May to August). From August to December, there are no serious problems with forage to feed livestock. Cows feed on forage mostly in near-by cropland after harvesting wheat (major cereal) and this continues as crops are harvested one after the other. Forage shortage, in certain times of the year, is also attributable to lack of land for forage making, growing of cash crops which do not produce forage residue such as potato and sunflower or lack of finance to purchase forage from the market in winter when the prices are unusually high.

The forage availability in BVG is comparable with Tashi and Partap (2000) findings from Tibet, where most herders suffer a huge loss of animals because of lack of supplementary feed during winter and spring. As a result, herders are caught in a vicious cycle of "weight gain in summer—fattening in autumn—weight loss in winter—death in spring." Further, Hodgson and White (1999) analyses the effects

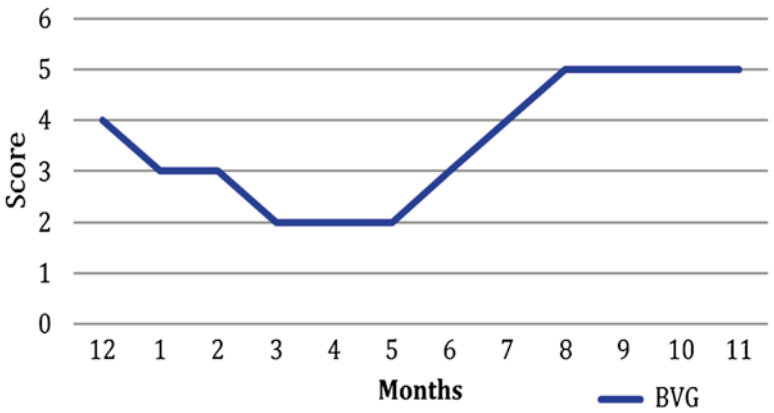


Fig. 5.6 Annual feed availability in the study area. *Source*: Field survey 2010. *Notes*: The score on the vertical axis ranges from 1 "serious feed scarcity" to 5 "no problem"

of underfeeding on animal production and found that underfeeding as challenge to meeting nutrient requirements in animals. At crucial stages of their life cycle, this can have major long-term effects. For young animals, restricted feeding is unlikely to be compensated by higher levels of feeding later in life, resulting in small-framed animals. Failure to meet target weights at mating may result in reduced ovulation rates, resulting in a failure to conceive or a lower proportion of multiple births. Poor feeding during pregnancy can result in substantial weight losses, low birth weights for the offspring and reduced milk yields in the ensuing lactation. Underfeeding in lactation causes lower milk yields and poorer growth rates in suckling calves. Loss of live weight in the dam will be recovered later in lactation at the expense of milk production. Based on the above discussions, it can be discerned that efficient use of forage plays major role in milk production. However, the amount of milk yield depends on calving season among other factors, which affects feed sufficiency.

In BVG, serious forage scarcity occurs from March to May. Lower feed sufficiency score in BVG is related to pasture shortage in early spring, which is mainly due to the early movement to pastures when grasses do not grow well (Fig. 5.6). Other times, animals will be grazed in near-village pastures or even in intensive pastures. In autumn, there is sufficient forage in near-village croplands after harvesting wheat (major cereal) until the end of harvesting of the other crops. In the study area, however, majority of cows are calved during winter and spring. Only a few cows calve in summer and autumn. Efficiency of milk will be enhanced if more cows give birth in autumn rather than spring, which coincide with periods of forage availability.

Apart from the above, there are other factors that cause forage shortage. Interviews with farmers and agricultural specialists indicate that climate change is contributing to the forage storage problem. Hay, forage grasses and forage crops such as Lucerne are maturing earlier as a result of higher temperature, allowing little time for farmers to mow grasses before they mature (Fig. 5.7). Farmers perceive that

Fig. 5.7 The sign of "Rainy season" in *Poacea* dominated hayland during mowing (*left*) and collecting time (*right*). *Source*: Field survey August 2010, BVG

mowing now starts 15–20 days earlier than before; grasses are also flowering earlier. In addition, the weather is becoming hotter and drier. As a result, grasses are maturing quickly, which reduce their nutritive value and digestibility. About 7–10 years ago, farmers used to have enough time for mowing; collecting and transporting hay back home. In recent times, however, the handling of forage is the main problem that leads to forage shortage. About 25 % of households found this to be a major problem, which is compounded by lack of hired labour to mow and store forage for use during the lean seasons.

Poor management reduces density and quantity of forage species, and increase quantity of poisonous and less nutritious forage species. During hay mowing, collecting and transporting time, heavy rains and hailstorms do occur, causing mud floods. The cloudy weather most of the time also makes drying of hay difficult. Hay content is mainly *Poacea* species, which in an inclement weather conditions, increase nitrate–nitrite poisoning of animals. When feed containing nitrate is eaten by ruminant animals, nitrate is converted to nitrite, and then to ammonia, by rumen microbes. Factors which cause nitrate to accumulate in the plant include drought, cloudy or cold weather. Hays made from cereal crops, especially those grown under drought conditions and cut while 'sappy' can develop toxic nitrite levels when they heat up. Oaten hay is particularly risky and becomes poisonous if previously dry hay is dampened by rain or snow some time before feeding out (Robson 2007). Most forage species at pasture and hayland suffer from triple risks of overgrazing, proliferation of non-edible plants and climate change. According to Ionov (2004), impact of climate change in South-Western Kyrgyzstan will increase desert area by 200 m, with aridization of 250 m in steppes and 150 m for rangelands. *Artemisia-Ephemera* 'community' with short spring vegetation will increase. It will cause pasture shortage during dry summer and autumn by putting pressure on near-village pastures. Thus, sustaining livestock production based mainly on pasture availability threatens agelong indigenious and current livestock production systems. It makes livestock production systems more vulnerable to climate and socioeconomic conditions. So, natural resource-based livestock management requires optimal use of stored forage from croplands and haylands during winter.

5.4 Conclusion

This chapter assesses the performace of dairying activities in the BVG, Ala-Buka, Kyrgyzstan The effect of calving seasons on the shape of the lactation curve is first analyzed. Estimates of the lactation curve show that initial milk yield is higher among winter and autumn cows than spring and summer calvers. The inclining and the declining slopes are, however, lower in winter and autumn compared to spring and summer. Peak milk yield and lactation persistence are key features of the lactation curve which aid farmers to select cattle breeds. Efficiency of milk production, in general, requires both high peak milk yield and lactation persistence. Calvers of all seasons have similar lactation persistence. Peak milk yield, however, varies markedly across calving seasons. The ranking of peak milk yield tends to match total milk yield in BVG. This implies that peak milk yield, therefore, can serve as a more reliable guide in selecting cattle breeds.

Apart from calving seasons, the availability of animal feed have influnetial effect on milk yield. Shortage of pasture forage is perceived by most households as the biggest problem they face. They attribute this situation to various factors including lack of land for forage making, growing of cash crops which do not produce forage residue such as potato and sunflower and lack of finance to purchase feed as exhobitant forage prices during the lean season. Poor forage management reduces density and quantity of forage species, and increase quantity of poisonous and less nutritious forage species. The sweltering heat in summer and drought conditions in spring might have direct negative impact on milk yield though negative consequences on pasture and animal physiology. It is recommended that farmers should plan calving seasons to match periods of forage availability. Milk yield can also be enhanced by protecting cattle from adverse climatic condtions.

References

Anwar M, Cain P, Rowlinson MS, Kahn M, Abdallah M, Babarerences ME (2009) Factors affecting the shape of the lactation curve in Nili-Ravi buffaloes in Pakistan. Pak J Zool 9:201–207

Beede DK, Collier RJ, Wilcox CJ, Thatcher WW (1985) Effects of warm climates on milk yields and composition (short term effects). In: Smith AJ (ed) Milk production in developing countries. Centre for Tropical Veterinary Medicine, University of Edinburg, Edinburg, pp 324–347

Dijkstra J, France J, Dhanoa M, Maas M, Hanigan M, Rook A, Beever D (1997) A model to describe growth patterns of the mammary gland during pregnancy and lactation. J Dairy Sci 80:2340–2354

Fitzherbert A (2005) Country Pasture/Forage resources profiles. Kyrgyzstan. Grassland and pasture crops. FAO: Bishkek. http://www.fao.org/ag/agp/AGPC/doc/Counprof/Kyrgystan/kyrgi.htm

Henry DR, Hall TJ, Jordan DJ, Milson JA, Schefe CM, Silcock RG (1995) Pasture plants of southern inland Queensland. Department of Primary Industries, Queensland

Hodgson J, White J (1999) New Zealand pasture and crop science. Oxford University Press, Auckland

Ionov P (2004) Vulnerability and adaptation of plant species and communities to climate change. UDK, Bishkek

Kamidi RE (2005) A parametric measure of lactation persistency in dairy cattle. ILRI Livest Prod Sci 96:141–148
Nogoev A (2008) Selectional-technological methods of increasing beef production in Kyrgyzstan. Bishkek
Olori VE, Brotherstone S, Hill WG, McGuirk BJ (1999) Fit of standard models of the lactation curve to weekly records of milk production of cows in a single herd. Livest Prod Sci 58: 55–63
Pollot G (2000) A biological approach to lactation curve analysis for milk yield. J Dairy Sci 83:2448–2458
Pollot G (2004) Deconstructing milk yield and composition during lactation using biologically based lactation models. J Dairy Sci 87:2375–2387
Robson S (2007) Nitrite and nitrate poisoning in livestock. NSW Department of Primary Industries, Australia. www.dpi.nsw.gov.au/primefacts
Rook A, France J, Dhanoa M (1993) On the mathematical description of lactation curves. J Agric Sci 121:97–102
Tashi N, Partap T (2000) Livestock based livelihoods in Tibet, China, and sustainability concerns. In: Tulachan PM, Saleem MA, Maki-Hokkonen J, Partap T (eds) Contribution of livestock to mountain livelihoods: research and development issues. ICIMOD, Kathmandu, pp 171–183
Wood PDP (1967) Algebraic model of the lactation curve in cattle. Nature 216:164–165
Wood PDP (1969) Factors affecting the shape of lactation curve in cattle. Anim Prod Sci 11:307–316
Wood PDP (1970a) A note on the repeatability of parameters of the lactation curve in cattle. Anim Prod 12:535–538
Wood PDP (1970b) The relationship between the month of calving and milk production. Anim Prod 12:253–259
Wood PDP (1980) Breed variations in the shape of the lactation curve of cattle and their implications for efficiency. Anim Prod 31:133–141
Wright I, Duncan A (2005) Livestock, fodder, pastures and people an integrated study in the northern areas of Pakistan. ICIMOD, Kathmandu
Zhumanova M, Maharjan KL (2012) Trends in livestock population and composition through derived productivity in Kyrgyzstan: a case study in Ala-Buka District. J Int Dev Coop 18(3): 159–176

Chapter 6
Farmers' Perception on Impact of Organic Farming on Yield and Income of Vegetables: A Case Study in Kathmandu Valley and Chitwan District of Nepal

Mrinila Singh and Keshav Lall Maharjan

Abstract Agriculture is the backbone of Nepalese economy. Commercialization of agriculture sector is deemed necessary for economic growth. However, its negative repercussions on environment and health of farmers stimulated organic movement in the country. Nonetheless this movement is still in its initial phase and lacks research based activities especially when it comes to assessing its impact on households. This study intends to analyze farmer's perception on yield and income from organic vegetable farming in Kathmandu valley and Chitwan district of Nepal. Study shows less than half of respondent perceived increased yield in organic vegetables. It also indicates their perception is positively related to experience of practicing organic farming and negatively to having large-sized farms. Thus, support should be provided during initial years as yield improves only in later years. Access to premium market assures increased income and compensates for decreased yield of organic vegetables. In this regard, consumer awareness on appearance of organic vegetables should be emphasized which could help establish and boost local organic vegetable market.

Keywords Certification • Income • Organic farming • Perception • Premium • Yield

6.1 Introduction

The system of how farming is being practiced has changed significantly at least in industrialized countries since the twentieth century. A massive breakthrough in agricultural technologies such as modern plant breeding, improved agronomic

M. Singh (✉) • K.L. Maharjan
Graduate School for International Development and Cooperation, Hiroshima University, Higashi-Hiroshima, Japan
e-mail: singh_mrinila@hotmail.com; mkeshav@hiroshima-u.ac.jp

K.L. Maharjan (ed.), *Communities and Livelihood Strategies in Developing Countries*,
DOI 10.1007/978-4-431-54774-7_6, © Springer Japan 2014

practices, and the development of inorganic fertilizers and modern pesticides brought remarkable changes in food production of these countries. The trend was followed much later by developing countries in Asia and Latin America in the late 1960s. Such conventional way of farming is termed as 'Green Revolution'. This method of farming usually involves mono-cropping, boosts economies of scale and at the same time decreases cost to the lowest possible. In addition to that, livestock growth, crop yield and disease prevention were also complemented using antibiotics and growth hormones. These changes in production methods in agriculture doubled output, lowered food prices and increased farmers' income which in turn stimulated the rural non-farm economy (IFPRI 2002).

On the other hand, Green Revolution has been criticized on social, economic and environmental grounds. It is argued that Green Revolution favors owners of large farms with better access to irrigation water, fertilizers, seeds, and credit while small farmers suffer from lower product prices, higher input prices and insecure tenancy rights (IFPRI 2002). There are regional disparities in the benefits of Green Revolution. Although the world per capita agricultural production has increased by over 25 % relative to 1960 level, Asia and Latin America increased per capita food production by 76 % and 28 %, respectively, while Africa experienced a decrease of about 10 % (DFID 2004). A study in Sub-Saharan Africa identified lack of infrastructure, high transport cost, limited investment in irrigation, and unsuitable pricing and marketing policies as factors that hinder farmers' ability to reap the benefits of Green Revolution. Unnecessary mechanization also lowered rural wages and employment. Further Green Revolution spread in irrigated or high potential rain-fed areas, leaving areas without access to sufficient water stranded. This contributed to increased income inequality, inequitable asset distribution, and thus worsened the absolute poverty (IFPRI 2002).

Excessive and inappropriate use of fertilizers and pesticides polluted waterways, poisoned agricultural workers, affected consumers through food residue, degraded land and killed beneficial insects and other wildlife. Mono-cropping system has reduced biodiversity. Irrigation practices build up salt in soil-surface leading to abandonment of some lands and receded groundwater levels where more water is being pumped up than can be replenished by the rains (IFPRI 2002; DFID 2004; Kassie and Zikhali 2009). It was also indicated that overtime yield remained stagnant or declined due to intensive and mono-cropping pattern system (Samie et al. 2010). The recognition of these problems has led to the pursuit of more sustainable forms of farming system, one among which is organic farming. According to IFOAM (2008):

> Organic agriculture is a production system that sustains the health of soils, ecosystems and people. It relies on ecological processes, biodiversity and cycles adapted to local conditions, rather than the use of inputs with adverse effects. Organic agriculture combines tradition, innovation and science to benefit the shared environment and promote fair relationships and a good quality of life for all involved.

Thus, organic farming relies on natural resources and local knowledge such as crop rotation, animal manures, green manures, natural enemies, pest-free plant

varieties, companion planting, etc. to control pests, weeds and diseases; and maintain health of soil and that of all the living organisms involved as well. Organic farming is known to be one of the most sustainable forms of agricultural production system. Many might perceive it as equivalent to the traditional form of farming being practiced without the use of modern inputs under Green Revolution; however, in a more strict sense, organic farming incorporates both traditional farming practices and modern scientific knowledge (HDRA 1998).

Organic farming in Nepal appears to be at an early stage of development. It is characterized by dearth of proper data, market information and research based activities (Bhatta et al. 2008, 2009; Pokhrel and Pant 2009). So far studies related to impact of organic farming on livelihood of farmers is very much lacking (Bhatta 2010). Besides, organic farming is made attractive in developing countries on the grounds of food self-sufficiency and/or receiving higher price. The only way subsistence farmers in developing countries can practice it sustainably is either by enhancing crop yield in order to maintain their household consumption or leveraging on premium price which would increase their purchasing power to consume more from the market and make up for the yield reduction. Thus, this chapter assesses how organic farming in a developing country like Nepal is benefiting farm households in terms of yield and income. In doing so, vegetable sector has been particularly emphasized for its market is growing.

The specific objectives of the study are enlisted as follows:

1. To evaluate impact of households' socio-economic characteristics on their perception of change in yield of organic vegetables
2. To examine farmer's access to premium market for organic vegetables with or without having certification
3. To assess change in farmer's income through organic vegetable farming as a result of change in yield and/or access to premium market

6.2 Literature Review

6.2.1 Organic Farming in Nepal

Agriculture is the dominant sector in Nepal contributing 35 % to gross domestic product (GDP) and employing 65 % of the economically active population (MoE 2011). Being the source of food, income and employment for majority of the population, agricultural sector has received support from Nepalese government through Green Revolution based technologies including chemical fertilizer, pesticides and high yielding varieties. Commercializing agriculture has been deemed necessary to bring much needed changes in economic growth of Nepal and to deal with key issues of poverty alleviation (Samriddhi 2011). The national education, research, extension and communication systems are mainly concentrated in high input

agriculture system in Nepal (Tamang et al. 2011). Even though chemical fertilizers and pesticides enhances crop yield, its long-term usage has damaging effect on environment. It is reported in Nepal that wanton use of farm chemicals has raised soil acidity thereby depleting soil physical condition and reducing underground water quality (Shrestha and Neupane 2002; Shrestha 2010). It is also noted that excessive use of chemicals worsen pest resistance, proliferation of new plant pests, forest degradation, flooding, erosion and drought (Bhatta 2010; KC 2006).

The negative repercussions of agrochemicals use on crop yield, environment and human health created the impetus for organic movement in 1986 in Nepal, and it has been growing gradually ever since. Other reasons for increase in this sector in Nepal are the continuous increase of price of chemical fertilizers and pesticides, and increasing demand from local and export market (Weiss 2004; Sharma 2005; Bhat 2009; Bhatta and Doppler 2010; Adhikari 2011; ANSAB 2011; Nepal 2011). Organic sector is also growing rapidly worldwide. Currently, 160 countries are practicing it on 0.9 % of the world's total agricultural land. Nepal, as of 2010, shared 0.23 % of the national agricultural land compared to just 0.001 % in 2001 (IFOAM 2003; FiBL-IFOAM 2012). It has potential to expand further owing to exclusion of costly agro-chemicals, ecological diversities and higher labor availability in the agriculture sector (Pokhrel and Pant 2009).

6.2.2 Organic Vegetable Farming in Nepal

Vegetables are considered cash generating crops that takes short period for getting marketable yield and is considered to generate more income than other crops, especially in areas that have easy access to market. Due to its features like making best use of land and labor, providing nutritional supplement and having potential to upgrade living standard, the Eighth Five Year Plan of Nepal clearly stated that vegetable cultivation can contribute towards meeting most of the development objectives through employment, income generation and health benefits (NPC 1992). Vegetable farming area as a whole increased by 23 % in 2003/04 compared to 1991/92 level and its yield also increased by 36 % within a same period (MoAC 2005).

In Nepal, the average chemical fertilizer consumption is 26 kg/ha which is quiet low compared to its neighboring countries like India (107.4 kg/ha), Pakistan (136.2 kg/ha), Bangladesh (166.20 kg/ha) and Sri Lanka (276.8 kg/ha). Similarly pesticide consumption also remains low at 0.142 kg/ha compared to countries like India (0.381 kg/ha), Indonesia (0.575 kg/ha), and China (2–2.5 kg/ha). Use of chemical fertilizers and pesticides are mainly prevalent in commercial production irrigated areas such as in Tarai and mid–hill regions (Aryal 2006; Paudyal 2010; Sharma et al. 2012). Among other crops, irrational use of agro-chemicals and pesticides in vegetable cultivation is stated to be more acute (Jha and Regmi 2009). Increasing number of pests and diseases led to simultaneous increase in use of

synthetic pesticides. Studies have shown that certain section of consumers who are aware of the harmful effects of pesticide residues are willing to pay more for organic products especially vegetables which have huge daily demands in urban areas and are mostly met by peri-urban growers in the valley (Bhatta 2010). Factors such as price, income, education and labeling has been fundamental aspects in purchasing organic vegetables and consumers are willing to pay 10–20 % more for labeled organic vegetables (Bhatta et al. 2008). Consequently there are growing number of farmers in peri-urban areas who are practicing organic partially specifically for income-generating crops like vegetables to benefit from such niche (premium) market (Bhatta and Doppler 2010). However, none of the vegetables are certified as organic and most of the organic vegetable production and marketing is done unsystematically, basically on the basis of community trust in Nepal. Producers, processors, distributors and consumers are mainly interlinked through loose marketing networks (Sharma 2005). At present, Nepal is exporting fresh vegetables to Tibet, Bangladesh and Arabian countries (Aryal 2006) thus making organic vegetables another potential export crop.

6.3 Study Methodology

Kathmandu valley which lies in mid-hill region and Chitwan district in Tarai region were selected purposively as the study sites. Demand for organic (vegetables) is growing inside the valley and thus farmers especially in peri-urban areas are also starting or increasing their share of organic farming to meet this emergent market. The presence of organic farming is more vibrant in the valley as can be seen in number of specialized markets, restaurants and other retailers asserting themselves to selling only or partly organic (Aryal et al. 2009; Bhatta et al. 2009). Recently in Chitwan district, there has been growing number of farmers practicing organic farming (Kafle 2011). Besides, non-governmental organizations (NGOs) are actively involved in supporting farmers' groups in adopting organic methods of crop production, inspection, product certification and marketing (Pokhrel and Pant 2009), particularly in peri-urban areas (Ghimire 2005), including Kathmandu valley and Chitwan district.

This study was carried out in two phases: the first visit was made in October till November of year 2011 and the second in June till July in 2012. In the first visit, 60 organic growers from each study areas were interviewed using semi-structured questionnaire. Farmer respondents were selected using snow ball sampling method. This method of sampling in research is used when the target members of a population are difficult to locate. To complement the data collected from household survey participant observation, group discussion and key informant survey were also carried out. The data was analyzed mainly descriptively using simple statistical tools such as frequencies, means, percentages, and cross tabulation for describing various parameters.

6.4 Results and Discussion

6.4.1 Socio-Economic Characteristics

This section describes socio-economic characteristics of respondents in the study areas, the summary statistics of which is presented in Table 6.1. About 47 % of the respondents in Kathmandu valley and 48 % in Chitwan district are male. The average age of farmers is about 41 years in Kathmandu valley and 42 in Chitwan district. In Kathmandu valley and Chitwan district, 63 % and 58 % of the respondents, respectively, have formal education. The average household size in Kathmandu valley is 5.33 and 5.1 in Chitwan district, both of which are higher than the national average of 4.88 (CBS 2011). On average, farmers in Kathmandu valley have been practicing organic farming for 8 years whereas in Chitwan district it is only for 6 years.

Most farmers belong to formal or informal groups related to organic farming. The activities they engage through such groups include training, saving and credit

Table 6.1 Summary statistics of socio-economic characteristics of respondents

	Kathmandu valley (KV) (n=60)				Chitwan district (CD) (n=60)			
Variables	Mean	Std. Dev.	Min. value	Max. value	Mean	Std. Dev.	Min. value	Max. value
Household characteristics								
Gender (male)	0.47	0.5	0	1	0.35	0.48	0	1
Age (years)	40.5	10.15	22	66	41.95	9.96	24	65
Literacy	0.63	0.49	0	1	0.58	0.5	0	1
HH size	5.33	1.68	2	10	5.1	1.67	3	10
Organic farming experience (years)	8.1	6.06	0.33	30	5.72	5.27	0.5	20
Group membership	0.88	0.32	0	1	0.97	0.18	0	1
Training received	0.93	0.25	0	1	0.97	0.18	0	1
LSU	5.96	20.16	0	132.8	2.22	1.56	0	9
Perception of increased yield	0.4	0.49	0	1	0.27	0.45	0	1
Certification	0	0	0	0	0.42	0.5	0	1
Premium market	0.58	0.5	0	1	0.03	0.18	0	1
Organic as major source of livelihood	0.4	0.49	0	1	0.08	0.28	0	1
Income increased from organic vegetable	0.5	0.5	0	1	0	0	0	0
Non-farm income	0.42	0.81	0	4	0.7	0.56	0	3
Farm characteristics								
Organic farm size (ha)	0.44	0.58	0.02	3.92	0.41	0.57	0.01	2.55
Ownership	0.72	0.45	0	1	0.9	0.3	0	1
Farm under organic (%)	0.58	0.5	0	1	0.62	0.49	0	1
Surrounded by conventional farm	0.43	0.5	0	1	0.67	0.48	0	1

Source: Field survey (2011)

Fig. 6.1 Farmers' market, one of the premium organic markets in Kathmandu valley

facilities, excursions, marketing and basically act as a link to development agencies such as I/NGOs and government. About 88 % of the respondents in Kathmandu valley are members of such group, slightly lower than Chitwan district where 97 % have membership. Similarly, 93 % of the farmers in Kathmandu valley have taken organic farming related training, again slightly lower than 97 % in Chitwan district. The average livestock standard unit (LSU[1]) is higher for farmers in Kathmandu valley (6) than in Chitwan district (2).[2]

Majority of farmers do not perceive yield of organic vegetables to be increasing. Only 40 % of the farmers in Kathmandu valley perceive increased yield after conversion to organic farming compared to just 27 % in Chitwan district. Yield in organic farming has always had a differing opinion. Some are of the opinion that feeding through organic agriculture comes with a huge cost of increasing land area and making available enough organically acceptable fertilizer (Trewavas 2002; Meisner 2007) whereas some have argued based on their studies that it indeed can be a solution to growing food demand and preserving environment at the same time given proper consideration is taken to fix microbial activities in soil and following intensive natural remedies to boost the production (Leu 2011; Brandt 2007).

None of the farmers are certified in Kathmandu valley but 58 % of them have access to premium market such as hotels, specialized outlets, embassy and middlemen who in turn connect the farmers' produce to these specialized markets (Fig. 6.1). Contrastingly, 42 % are certified in Chitwan district but none have access to premium

[1] LSU is aggregate of different types of livestock kept at household in standard unit which is calculated as: 1 adult buffalo = 1 LSU, 1 immature buffalo = 0.5 LSU, 1 cow = 0.8 LSU, 1 calf = 0.4 LSU, 1 pig = 0.3 LSU, 1 sheep or goat = 0.2 LSU and 1 poultry = 0.1 LSU (CBS 2003).

[2] This rather huge difference between livestock holding in these two areas can be explained by the fact that one of the farmers in Kathmandu valley is practicing livestock farming on a commercial scale with 133 LSUs. Excluding this, the average livestock holding for farmers in Kathmandu valley would still be higher (3.9) compared to Chitwan district (2.22).

market for organic vegetables. For 40 % of households in Kathmandu valley and only 8 % in Chitwan district, organic farming is the major source of household income. Some 50 % in Kathmandu valley and none in Chitwan district found increased income from organic vegetable farming. About 42 % in Kathmandu valley and 56 % in Chitwan district depends on non-farm sources of income as well. When it comes to organic farm characteristics, on average it is practiced in 0.44 ha in Kathmandu valley and 0.41 ha in Chitwan district. Seventy-two percent of the farmers in Kathmandu valley and 90 % in Chitwan district own the farm land. Only 58 % in Kathmandu valley and 62 % in Chitwan district have converted all of their farm land into organic. For some this partial conversion means balancing for the lower yield from organic farming. They opined that instant conversion of farm from conventional to organic will affect the yield dramatically, so it is better to change gradually by decreasing the proportion of chemical fertilizers used and increase that of organic fertilizers. Some faced production loss during initial years after conversion and was compelled to switch part of their land into inorganic practice due to economic reasons. Some on the other hand chose to do it only on small scale, particularly for growing vegetables to make it more manageable in terms of plant pest and weed management, supplying with enough organic inputs such as manure and higher labor requirement as well as in case of Kathmandu valley to benefit from the growing premium market. Also from the survey it is found that 43 % in Kathmandu valley and 67 % in Chitwan district have their organic farm surrounded by conventional farm.

6.4.2 Impact of Socio-economic Characteristics on Farmer's Perception of Change in Yield of Organic Vegetables

Farmer's perception on yield of organic vegetables has been associated with various socio-economic characteristics (Table 6.2) to see if there exists any significant relation.

Age of farmers, household size, group membership in a formal/informal group (association), organic farming related training, livestock holding, non-farm income source, land ownership and organic farm surrounded by conventional farm did not show significant relation to farmer's perception on yield of vegetables. The study finds that more males than females perceive organic farming to have no (56 %) or decreasing (58 %) effect on yield of vegetables in Kathmandu valley. Similarly, 83 % of literate farmers in Kathmandu valley perceived decreased yield. In Chitwan district, 69 % of farmers who have been practicing organic farming for more than 5 years perceived increased yield of vegetables. This somehow can relate to the study by Halberg et al. (2006) and Zundel and Kilcher (2007) which claims that conversion to organic can result in lower yield in initial years, usually the first 2 to 3 years, if the land had been exposed to chemical fertilizers intensively or for a long time period; but can produce better results as well if farmers had been practicing traditional farming before conversion. Yield under organic can even surpass conventional system if the land had been run on a low-input level.

Table 6.2 Relation of socio-economic factors and perception on organic vegetables' yield

		Perception on organic vegetable yield				
Site	Factors	Increased	Same	Decreased	Total	P-value
	Gender					
KV	Male	5 (25)	9 (56)	14 (58)	28 (47)	0.059*
CD	Male	4 (27)	10 (34)	7 (44)	21 (35)	0.607
	Age					
KV	Above 40 years	11 (55)	11 (69)	9 (38)	31 (52)	0.143
CD	Above 40 years	10 (67)	14 (48)	8 (50)	32 (53)	0.487
	Education					
KV	Literate	11 (55)	7 (44)	20 (83)	38 (63)	0.025**
CD	Literate	10 (67)	14 (48)	11 (69)	35 (58)	0.309
	Household size					
KV	More than 5	6 (30)	5 (31)	11 (46)	22 (37)	0.484
CD	More than 5	7 (47)	8 (27.59)	4 (25)	19 (32)	0.348
	Organic farming experience					
KV	More than 5 years	14 (70)	13 (81)	14 (58)	41 (68)	0.306
CD	More than 5 years	11 (69)	10 (34)	3 (20)	24 (40)	0.015**
	Association					
KV	Yes	18 (90)	14 (88)	21 (88)	53 (88)	0.960
CD	Yes	15 (100)	27 (93)	16 (100)	58 (97)	0.331
	Training					
KV	Yes	20 (100)	15 (94)	21 (88)	56 (93)	0.253
CD	Yes	15 (100)	28 (97)	15 (94)	58 (97)	0.625
	LSU					
KV	More than 3	6 (25)	2 (13)	1 (5)	9 (15)	0.309
CD	More than 3	6 (38)	7 (24)	5 (33)	18 (30)	0.287
	Organic as source of livelihood					
KV	Full dependency	14 (70)	5 (31)	5 (21)	24 (40)	0.003***
CD	Full dependency	2 (13)	3 (10)	0 (0)	5 (8)	0.35
	Income change from organic vegetable farming					
KV	Increased	4 (20)	7 (44)	19 (79)	30 (50)	0.000***
CD	Increased	0 (0)	0 (0)	0 (0)	0 (0)	
	Non-farm income					
KV	Yes	8 (3)	2 (13)	8 (40)	18 (30)	0.182
CD	Yes	10 (63)	20 (69)	10 (67)	40 (67)	0.908
	Organic share in ha					
KV	More than 1 ha	1 (5)	2 (13)	5 (21)	8 (13)	0.471
CD	More than 1 ha	0 (0)	3 (10)	2 (13)	5 (8)	0.078*
	Ownership of farm land					
KV	Owned	16 (67)	10 (63)	17 (85)	43 (72)	0.258
CD	Owned	13 (81)	27 (93)	14 (93)	54 (90)	0.395
	% of farm under organic					
KV	100 %	12 (50)	6 (38)	17 (85)	35 (58)	0.009***
CD	100 %	15 (94)	16 (55)	6 (40)	37 (62)	0.005***
	Farm surrounded by conventional farm					
KV	Yes	12 (50)	8 (50)	6 (30)	26 (43)	0.338
CD	Yes	12 (75)	17 (59)	11 (73)	40 (67)	0.439

Source: Field survey (2011)

Note: KV stands for Kathmandu valley and CD for Chitwan district; Figures in parenthesis indicate column percentage; ***Significant at 1 %, ** at 5 % and * at 10 % level of significance

In Kathmandu valley about 70 % and 21 % of those who solely depend on organic farming for their livelihood perceived increased and decreased yield of organic vegetable, respectively. This could imply that farmers are more committed to improving yield when farming is the only means of support. About 79 % of the farmers in Kathmandu valley who perceived decreased yield have experienced increase in income. Thus, this indicates that higher number of farmers in Kathmandu valley are able to compensate for their decreased yield in organic vegetables through increase in income.

In Chitwan district, 13 % of those who perceived decreased yield also has more than one hectare of organic farm but none of the farmers with this farm size perceived increased yield. Ferguson et al. (2011) suggested that organic farming in bigger farm land could be difficult mainly due to the fact that it demands more labor. Again, in both areas, farmers having all of their farms area under organic practice has significant relation to yield perception. In Kathmandu valley, 85 % of those perceiving decreasing yield of vegetables have all of their farms under organic management. Contrastingly, in Chitwan district, about 94 % of those perceiving increased yield of vegetables have all of their farm under organic management.

6.4.3 Impact of Certification and Access to Premium Market on Income from Organic Vegetable Farming

Only farmers in Chitwan district are certified as organic or in the process of being organic. Agencies basically divide certification into two categories. A farm is said to be organic certified when it satisfies all the necessary conditions of the related agency. On the other hand it is said to be in the process of conversion, which means it has already discontinued the use of chemical fertilizers or other restricted inputs but requires certain time for soil to be fully organic. Although 42 % of households are certified in Chitwan district (Table 6.1), none of them have access to premium market for organic vegetables and thus no increase in income has been realized so far on organic vegetables. Some farmers whose income has increased through certification in Chitwan district is restricted to selling only cereal crops[3] but not vegetables. Generally there is no local premium market for organic products in Chitwan district. Even if it is to be considered for export in other cities where market is available, poor infrastructure and lack of cooling system deteriorates the quality of vegetables when it reaches its destination of sale, thus making it an unlikely preference for households. Thus, lack of premium market compelled these farmers to sell organic vegetables at same price or even low compared to others. The physical form

[3] An access to exporting cereal crops such as rice, wheat, buckwheat, paddy, beans and lentils has contributed to increase in farmers' income after certification in Chitwan district. These are sold in other cities from where farmers can get 20 % premium. Although the demand was, according to farmers, quiet low and unstable. Late payment through such medium was also one of the concern farmers shared during the survey.

Table 6.3 Premium market and change in income from organic vegetables in Kathmandu valley

Marketing	Increased	Same	Decreased	P-value
Local market	11 (30)	6 (17)	19 (53)	0.00***
Acquaintances	9 (53)	0 (0)	8 (47)	
Hotels	5 (100)	0 (0)	0 (0)	
Organic outlet	9 (64)	5 (36)	0 (0)	
Embassies	1 (50)	1 (50)	0 (0)	
Middlemen	10 (91)	0 (0)	1 (9)	

Source: Field survey (2011)
Note: Figures in parenthesis indicate row percentage. ***Significant at 1 % level

of organic vegetables which consumers found to be poor that are usually disfigured, dull colored with less brightness/shine in appearance, smaller in size and even having small holes from pest attack also added to difficulty in selling. Problems such as, lack of awareness, information dissemination and knowledge among consumers have left these farmers with no option but to sell their vegetables often at lower price than usual. Bhatta et al. (2009) also suggests that in Nepal consumers at large are still price oriented and lack awareness on health benefits of consuming organic and so selling organic is still limited to only a small section of consumers.

The impact of access to premium market on farmer's income in Kathmandu valley has been shown in Table 6.3. As can be seen from the table above, farmers in Kathmandu valley have access to various high-end markets for organic vegetables besides local market and acquaintances. About 53 % of those who sell organic vegetables in local market have experienced decrease in income. Farmers in Kathmandu valley also have similar opinion of poor physical appearance of organic compared to inorganic vegetables and lack of consumer awareness sometimes lead them to sell it at lower price instead. Despite of being situated in Kathmandu valley, due to long distance to the center market, poor transportation and limited amount and varieties of vegetables, it is not feasible for some farmers to trade where price is high. Again 53 % of households selling to acquaintances increased income from organic vegetables.

Most of the farmers who sell in these premium markets have already established consumer or middlemen relation where they have been getting premium price solely based on mutual trust. Mutual trust here implies that without any written agreement or law to back the communicated information, consumers solely base their trust about the authenticity of organic produces according to their close contact/relation with the seller. Thus, this reveals that even without certification farmers in Kathmandu valley could increase their income from organic vegetable farming.

6.5 Conclusion and Recommendations

This study finds that households having more experience in organic vegetable farming are better off in realizing the benefits from this farming through improved yields. Also those who receive major portion of their income from organic farming tend to

produce better vegetable yield. The study likewise suggests that yield of organic vegetables could be lower in large sized farms perhaps because it becomes more difficult for higher pest and disease management, amount of organic inputs required and labor demand. From the case of Kathmandu valley, decrease in organic vegetable yield could be compensated by increased income because of the availability of various local premium markets. Nonetheless, lack of premium market in Chitwan district and lack of awareness among consumers in terms of appearance of organic vegetables have led farmers to sell them at same or even lower price.

Based on this study organic (vegetable) farming could be difficult in initial years as the yield performance gets better only after few years. Thus, it is suggested that those who are taking this initiative should be encouraged through some kind of support such as crop insurance or relief and credit facilities in the initial years. Organic (vegetable) farming might not perform well in big-sized farms probably because of the additional level of inputs such as labor it requires. However, yield decrease in such cases could be compensated if premium markets exist. Emphasis should be given on consumer awareness on appearance of organic vegetables which could help establish and boost local market for organic vegetables.

References

Adhikari RK (2011) Economics of organic rice production. J Agr Environ 12:97–103

ANSAB (2011) Organic agriculture: a promising sector for income generation in Nepal. Asia Network for Sustainable Agriculture and Bioresources (ANSAB), Kathmandu. http://www.ansab.org/publication/organic-agriculture-a-promising-sector-for-income-generation-in-nepal/. Accessed 20 Sept 2013

Aryal S (2006) Concept, status, prospects and opportunities of organic farming in Nepal. In: Proceedings of a first national workshop on organic farming. Directorate of Agriculture Extension, Kathmandu, pp 27–34

Aryal KP, Chaudhary P, Pandit S, Sharma G (2009) Consumers' willingness to pay for organic products: a case from Kathmandu valley. J Agr Environ 10:15–26

Bhat BR (2009) Opportunity and challenge of organic certification system in Nepal. J Agr Environ 10:124–128

Bhatta GD (2010) Stakeholder and spatial perspectives of organic farming in Nepal. LAP LAMBERT Academic Publishing, Deutschland

Bhatta GD, Doppler W (2010) Socio-economic and environmental aspects of farming practices in the peri-urban hinterlands of Nepal. J Agr Environ 11:26–39

Bhatta GD, Ranabhat A, Subedi M (2008) Consumer's awareness and willingness to pay for organic vegetables in the Kathmandu Valley. Green Field J HICAST 6(1):52–61

Bhatta GD, Doppler W, KC KB (2009) Potentials of organic agriculture in Nepal. J Agr Environ 10:1–11

Brandt K (2007) Organic agriculture and food utilization. Newcastle University, UK

CBS (2003) National sample census of agriculture Nepal, 2001/02. National Planning Commission Secretariat, Central Bureau of Statistics, Kathmandu

CBS (2011) National population and housing census 2011 (national report). National Planning Commission Secretariat, Central Bureau of Statistics Nepal, Kathmandu

DFID (2004) Agricultural sustainability. Department for International Development, UK

Ferguson SM, Weseen S, Gray R, Khaledi M, Sawyer E (2011) Factors influencing partial and complete adoption of organic farming practices in Saskatchewan, Canada. Can J Agr Econ 58(1):37–56

FiBL-IFOAM (2012) The world of organic agriculture. Statistics and emerging trends 2012. In: Helga W, Kilcher L (eds.). Research Institute of Organic Agriculture (FiBL), Frick and International Federation of Organic Agriculture Movements (IFOAM), Bonn

Ghimire M (2005) Organic agricultural product certification in Nepal: process and practices. In: Proceedings of workshop on organic agriculture and food security, Kathmandu, Nepal

Halberg N, Sulser TB, Hogh-Jensen H, Rosegrant MW, Knudsen MT (2006) The impact of organic farming on food security in a regional and global perspective. In: Halberg N, Alroe HF, Knudsen MT, Kristensen ES (eds) Global development of organic agriculture: challenges and prospects. CABI, Wallingford, pp 277–322, Chapter 10

HDRA (1998) What is organic farming? Henry Doubleday Research Association, Warwickshire

IFOAM (2003) The world of organic agriculture: statistics and future prospects 2003. In: Yussefi M, Willer H (eds.) International Federation of Organic Agriculture Movements (IFOAM), Tholey-Theley

IFOAM (2008) Definition of organic agriculture. International Federation of Organic Agriculture Movements (IFOAM), Bonn. www.ifoam.org: http://www.ifoam.org/growing_organic/definitions/doa/index.html. Accessed 20 Mar 2012

IFPRI (2002) Green revolution: curse or blessing? International Food Policy Research Institute (IFPRI), Washington

Jha RK, Regmi AP (2009) Productivity of pesticides in vegetable farming in Nepal. Centre for Rural Development and Self-Help (CRDS), Kathmandu

Kafle B (2011) Factors affecting adoption of organic vegetable farming in Chitwan District, Nepal. World J Agr Sci 7(5):604–606

Kassie M, Zikhali P (2009) Sustainable land management and agricultural practices in Africa: bridging the gap between research and farmers. University of Gothenburg, Gothenburg

KC GK (2006) An idea on organic agriculture system in Nepal. In: Proceedings of a first national workshop on organic farming. Directorate of Agriculture Extension, Kathmandu, pp 10–26

Leu A (2011) Scientific studies that validate high yield environmentally sustainable organic systems. Organic Federation of Australia, Mossman

Meisner C (2007) Why organic food can't feed the world. Cosmos online: http://www.cosmosmagazine.com/features/online/1601/why-organic-food-cant-feed-world. Accessed 29 Oct 2011

MoAC (2005) Statistical information on Nepalese agriculture. Ministry of Agriculture and Cooperatives, Kathmandu

MoE (2011) Status of climate change in Nepal. Ministry of Environment, Government of Nepal, Kathmandu

Nepal AP (2011) Study on the microbial additive compost for organic farming system. Interdisciplinary Graduate School of Agriculture and Engineering, University of Miyazaki, Japan

NPC (1992) Eighth five year plan (1992/93–1996/97). National Planning Commission, Nepal

Paudyal KP (2010) Organic agriculture in Nepal. ANSOFT Workshop, Suwon

Pokhrel DM, Pant KP (2009) Perspective of organic agriculture and policy concerns in Nepal. J Agr Environ 10:89–99

Samie A, Abedullah Ahmed M, Kouser S (2010) Economics of conventional and partial organic farming systems and implications for resource utilization in Punjab (Pakistan). Pakistan Econ Soc Rev 48(2):245–260

Samriddhi (2011) Commercialization of agriculture in Nepal. Samriddhi–The Prosperity Foundation, Kathmandu

Sharma G (2005) Organic agriculture in Nepal: an analysis into status, policy, technology and psychology. Paper presented at the National workshop on organic agriculture and food security, Kathmandu, Nepal

Sharma DR, Thapa RB, Manandhar HK, Shrestha SM, Pradhan SB (2012) Use of pesticides in Nepal and impacts on human health and environment. J Agr Environ 13:67–74

Shrestha RK (2010) Fertilizer policy development in Nepal. J Agr Environ 11:126–137

Shrestha PL, Neupane FP (2002) Socio-economic contexts on pesticide use in Nepal. Landschaftsökologie und Umweltforschung 38:205–223

Tamang S, Dhital M, Acharya U (2011) Status and scope of organic agriculture in Nepal. Food and Sustainable Agriculture Initiative, Forestaction, Lalitpur
Trewavas A (2002) Malthus foiled again and again. Nature 418:668–670
Weiss J (2004) Global organics. http://newhope360.com/agriculture/global-organics. Accessed 16 Mar 2012
Zundel C, Kilcher L (2007) Organic agriculture and food availability. Research Institute for Organic Agriculture (FiBL), Switzerland

Chapter 7
Riverbed Vegetable Farming for Enhancing Livelihoods of People: A Case Study in the Tarai Region of Nepal

Gam Bahadur Gurung, Dharma Prasad Pande, and Narayan Prasad Khanal

Abstract Enhancing livelihoods through the promotion of appropriate technical and social means is the popular strategy being adopted by development projects in the developing countries. Riverbed vegetable farming is a pro-poor program intended to contribute on livelihoods of people, especially landless and victims of disasters. In partnership with Plan Nepal, Forum for Rural Welfare and Agricultural Reform for Development piloted riverbed vegetable farming from 1998 to 2010 in Morang and Banke districts of Nepal. A total of 333 households organized into 17 groups were engaged in riverbed vegetable farming in these districts. Farmers grew cucurbit species on riverbed areas. Result indicates that this program has improved the livelihood of people, especially in the vulnerable groups in these communities. Moreover, the benefit-cost analysis of riverbed vegetable farming shows that bottle gourd accrues highest benefits, and average benefit cost ratio from this farming is around two. Moreover, this farming practice has been found to be appropriate to enhance family nutrition and cash income. In spite of the great contribution of riverbed vegetable farming, this practice is suffered from poor soil nutrition, stray animals, strong windstorms, and long spell of droughts. More understanding is needed how this practice could be widely scaled out through innovation platform of government and non-government organizations across the potential domains of this practice.

Keywords Benefit-cost analysis • Cucurbit species • Landless • Leader farmers • Livelihoods • Riverbed vegetable farming

G.B. Gurung • D.P. Pande (✉)
Forum for Rural Welfare and Agricultural Reform for Development,
Bharatpur 2, Kshetrapur, Chitwan, Nepal
e-mail: ctwforward@wlink.com.np; ctwforward@wlink.com.np

N.P. Khanal
Graduate School for International Development and Cooperation, Hiroshima University,
Higashi-Hiroshima, Japan
e-mail: narayankhanal36@gmail.com

K.L. Maharjan (ed.), *Communities and Livelihood Strategies in Developing Countries*,
DOI 10.1007/978-4-431-54774-7_7, © Springer Japan 2014

7.1 Introduction

Agriculture is the basis of livelihoods for more than 65 % of Nepalese particularly those living in the rural areas. It is the mainstay of the national economy, contributing 34 % of the national gross domestic product (GDP) of Nepal (World Bank 2007). Over 50 % of Nepalese live under absolute poverty of less than $1.25 a day (Dhungel 2009). The country has an arable land of about 2.5 million hectares, representing only 17 % of land area (FAO 2007). Over the past few decades, there has been spiraling population growth making arable land limited for food production. The growth rate of cereal production over the past 5 years still remains low at 1.2 % per year, which is below the national population growth rate (1.4 %) (FAO 2007). It is estimated that, if the current population growth trend continues, 3.9 million people in rural Nepal will become food insecure and 2.5 million people would need immediate assistance within 2 years (FAO 2008). Furthermore, agricultural production systems in rural areas are still dominated by smallholder subsistence farmers with low production input use. There is now an immediate need to revitalize the traditional farming systems through integration of modern technologies, optimal utilization of locally available resources and a smooth transition to market-oriented production systems in a sustainable manner. For this to happen, technology and innovation systems must go well beyond raising crop yields to include issues of raising overall farm productivity and profitability to meet the challenges of increasing resource scarcity in changing socioeconomic and climatic conditions.

The overwhelming global issue of climate change is more prominent in Nepal being a fragile mountainous country in South Asia with poor adaptive capacity (Government of Nepal (GON) 2009). Erratic and unpredictable rainfall patterns, extreme temperature (both in summer and winter) and hot and cold waves have been experienced in recent years. As a consequence, landslides, soil erosion, flash floods, droughts and famine have been on the increasing trend (Dhungel 2009; NAPA 2010). Climate change has induced direct impacts on natural and human systems altering productivity, biodiversity and functions of many ecosystems and livelihoods. The agriculture sector is adversely affected by climate change and the rural poor are most vulnerable to adverse climate change impacts in Nepal (Rai 2007; Helvetas Nepal 2010; NAPA 2010; Maharjan and Joshi 2013). In this context, development efforts that diversify livelihoods options based on local knowledge and resources can enhance capability of people to effectively utilize natural resources in coping with uncertain livelihood outcomes emanating from changing climate (Piya et al. 2012). Forum for Rural Welfare and Agricultural Reform for Development (FORWARD Nepal) has been empowering farming communities to adapt to natural hazards triggered by climate change. These communities are those who are especially victims of natural disasters such as flood and are in the form of landlessness. This chapter presents the findings of the action research project titled riverbed vegetable farming implemented by FORWARD in Morang and Banke districts of Nepal.

7.2 Program Implementation Methodology

7.2.1 Selection of Project Site and Households

The landless and land poor families residing in the vicinity of rivers with the potential of riverbed farming were selected. While selecting the participants, preferences were given to households who lost their land by floods or riverbank erosion, and those who were facing acute food and nutritional insecurity, and making their livelihoods mainly from share cropping of rice production and wage laboring. It means the participant households were both landless and with marginal land size and willing to participate in the riverbed vegetable farming. Fields with silty alluvial soil and having water table of 0.60–0.75 m below the land surface is considered conducive for riverbed farming as there might be possibility of high seedling mortality in lower soil depth, and if water table is too low crops might be suffering from water stress. Wherever landless families did not have their own riverbed area, the land was rented in from other riverbed owners and/or from Village Development Committees (VDCs), the lowest administrative tier of Nepal. The project facilitated the interested farmers to be organized into groups (5–28) depending up on the number of interested households for riverbed farming and availability of appropriate riverbeds. The organized households were facilitated to make contractual arrangement with landlord or VDCs for 1–3 years. On an average the rent for riverbed area was NRs 400 per *kattha* (333 m^2 area) per year. From the year 2010/11 to 2012/13, there were three groups in Morang district and 25 groups in Banke district for riverbed vegetable farming. Out of the total 758 participating farmers in the two districts, 77.97 % were men and 22.03 % were women.

7.2.2 Empowerment of Groups in Technical and Managerial Skills

After the organization of participating members into groups, each group selected riverbed area in blocks for commercial vegetable production. In this process, the project mobilized local leader farmers, one in each block, having practical experience in riverbed farming and competency in local language. The leader farmers got orientation trainings about the technical issues of river beds and group empowerment strategies. All the groups were assisted to prepare an action plan for the production and marketing of fresh vegetables. After preparing the group plan, 1-day practical training on riverbed vegetable production was given to all producer groups by local leader farmers and project staff. In addition to the trainings, arrangements were made for the provision of vegetable seeds, chemical fertilizers and plant protection materials to the producer groups on full subsidy basis in the first year. Subsidy on production inputs were gradually reduced to 75 % and 50 % with cost sharing by each participant in the second and third years, respectively. From the fourth year, no

subsidy was provided, and participants continued to produce vegetables on their own. However, technical and managerial supports were provided from the project side through community mobilization and field technicians. Producer groups conducted monthly meetings to discuss the on-going activities, associated problems and to figure out possible solutions. They also created a group fund by their savings which was given out as loans to the members for productive purposes.

7.2.3 Technology of Riverbed Vegetable Production

While discussing about the technology of riverbed farming, it is important to consider two issues: crop varieties appropriate for riverbed farming and crop husbandry practices. Cucurbit species were promoted in river beds because of their long tap root system and their suitability to grow on the winter season. More specifically, these crops were water melon (*Citrullus lanatus*), cucumber (*Cucumis stivus L.*), bottlegourd (*Lagenaria siceraria*), summer squash (*Cucurbita pepo*), bitter gourd (*Momordica charantia*), pumpkin (*Cucurbita moschata*), pointed gourd (*Trichosanthes dioica*) and sponge gourd (*Luffa cylindrica*). In addition, tomato (*Lycopersicon esculentum*) and sweet potato were also promoted in some areas. These crops are grown from September to May because land is not suitable for growing crops from June to August due to flood and high soil moisture. Farmers argued that sweet potato is planted in the first week of September and harvested in mid-December. However, cucurbits are grown during spring season (starting from February). It is also possible to grow cucurbits after harvesting sweet potato but cucurbits planted early (before harvesting of sweet potato) fetch higher price in the market because of the shortage of vegetable in the market during that time. To harvest these vegetable early, farmers prepare seedling in the protected areas inside plastic bucket, and the seedlings are transplanted in pits. The size of pits is 0.65×0.65 m, and the distance from row to row and plant to plant was maintained at 1.5–2.0, and 1 m, respectively. In each pit, farmers used 3–5 kg compost, 10 g urea, 25 g dia-ammonium phosphate, 15 g of murate of potash and 2 g borax at the time of seeding (Chapagai and Pande 2006).

Majority of farmers directly sow seed in pits @ 300–350 g ha^{-1} for cucumber, 450–500 g ha^{-1} for bottle gourd and sponge gourd, and 1.5 kg ha^{-1} for water melon and bitter gourd (Fig. 7.1) Cucurbit seeds were soaked in water for 24 h, floating seeds were removed and remaining seeds were air dried. Then seeds were wrapped in big sized green leaves, again wrapped by muslin clothes and it was put into compost heap for 3–4 days for germination. After germination, two seeds were sown per pit. After sowing the seeds, mulching was done using locally available dry grasses. Sowing of seeds is done between November and December. However, early sown seeds showed better performance because of good emergence and early plant vigour before the extreme cold season. Some of the riberbed vegetable producer groups keep vegetable nursery under plastic tunnel sowing the seeds polypots containing a mixture of soil and compost. The plastic tunnel are opened during the day time and

Fig. 7.1 Bitter gourd grown on the riverbed in Morang district

closed during the night time. Seedlings were transplanted into the pits from the second week of February.

After transplanting seedlings into pits farmers apply nitrogenous fertilizer (urea), hormone/plant growth regulators and pesticides, and irrigation is not normally practiced. For each plant receives 15 g urea after 20–25 days of sowing and again 15 g urea per plant after 40–45 days after sowing as top-dress. If plants show any deficiency of micronutrients (normally during flowering stage), 1.0–1.5 ml multiplex per litre of water is sprayed on the crops. Crops infested by red pumpkin beetles, aphids, fruit flies were controlled by hand picking or spraying cattle urine (1:5 urine to water ratio) as a pest repellant. Root rot, powdery mildew and downy mildew were major diseases which are controlled by spraying appropriate fungicides (Chapagai and Pande 2006).

7.2.4 Record Keeping

A group profile format was developed to record data from all producer groups in consultation with the leader farmers. Then leader farmers facilitated each group how to record information related to riverbed vegetable farming. The groups collected information at monthly interval. Data on number of participants, area under riverbed farming, total amount of vegetable production, household consumption, sales volume, sales values, cost of production and net profit was collected in the record book. In addition to this, the groups also collected problems and lessons

learnt from the vegetable farming activities. A total of 20 group leaders from different producer groups were selected for the calculation of benefit-cost ratio of riverbed vegetable farming. Similarly, the cost of cultivation and incomes were recorded from group leaders for calculation of the net profit.

7.3 Results and Discussion

7.3.1 Area, Production and Income

The study shows that in the course of 3 years, the area under riverbed vegetable farming reached to 57.7 ha in Banke and 41 ha in Morang in the project area. The vegetable yield in Banke (12.6 t/ha) is lower than that of Morang (25.6 t/ha). The exact reason behind this problem is not yet fully understood; however, farmers believe that more severe drought and heat wave in Banke might be one of the reasons for it. The increase in vegetable area and yield in these areas is not just due to the project itself but as a result of consorted efforts from government agencies and other NGOs. For instance when this technology was first introduced by FORWARD in 1998 in Morang district, the success stories of getting benefits from unused lands started disseminating in other areas through various innovation platforms of government and NGOs. As a consequence, the Riverbed Alliance comprising of donor agencies, non-governmental organizations (NGOs) and government bodies was formed in 2010 to influence government policy.

Vegetables produced by farmers on riverbeds were primarily sold for income generation, with a small fraction of output consumed by the farm families. Out of the total output of vegetables produced by growers in three cropping cycles, 95 % was sold in the market (Fig. 7.2) whereas 5 % was consumed by their families. Some farmers exchanged fresh vegetables with food grains (paddy and wheat) of their neighbours, which indirectly contribute to their food security situation. The area under riverbed vegetable farming, total volume of production, household consumption, sales volume and sales values for three consecutive years are presented in Table 7.1. The average income per household from riverbed vegetable farming per cropping cycle is NRs 21,454 and NRs 21,930 in Banke and Morang, respectively.

Net profit per household is NRs 10,290 and 7,697 in Banke and Morang, respectively. Though the total net profit per household is higher in Banke than that of Morang, the net profit per unit area is higher in Morang (NRs 3,387) as compared to Banke (NRs 2,627).

The large proportion of income generated from riverbed vegetable growers is used for purchasing food grains for household food security needs. Part of their income is set aside for the health needs of family members, and for the education of their children. They also accumulate some physical assets like goats, cows, buffaloes and land from their income which further helped to improve the livelihoods of landless and land poor families especially in the long run. It is worth mentioning

Fig. 7.2 Farmers' selling cucurbits in the market

that more than 12 % of landless families purchased land using the income from vegetables and become land owners. Similarly, accumulation of wealth at household level has reduced the urgency of taking loan at exorbitant interest rate (up to 36 % per year). In group discussion farmers claimed that after involving in riverbed vegetable farming the cases of going to India for seasonal wage laboring has also been significantly reduced. Moreover, drawing on the skills and innovations from riverbed farming, some farmers in both the districts have started growing vegetables by leasing land by themselves.

7.3.2 Benefit-Cost Analysis of Riverbed Vegetable Farming

The benefit-cost ratio of riverbed vegetable farming was found 2.5 with ranges from 1.4 to 4.8 (Fig. 7.3). Farmers had smaller benefit-cost ratio in situations where vegetables are damaged due to grazing by stray animals, strong windstorms and early water stress during March/April.

The benefit-cost ratio also varied with types of vegetable crops grown because farmers grow different combinations of vegetables in their farms. All participating farmers grow at least three crops to minimize risk of production and market failures. Majority of farmers grow bottle gourd, water melon and cucumber in combination. The benefit-cost ratios of each crop are shown in Fig. 7.4. Bottle gourd is the most profitable vegetable crop for the riverbed farmers. If all farmers grow bottle gourd,

Table 7.1 Summary of area, production, consumption, sales volume, sales values and net profit of riverbed vegetable farming

District	Year	Area (ha)	Total members	Production and sales (t)			Total income (NRs '000)	Production cost (NRs '000)	Net profit (NRs '000)
				Consumed	Sales	Total			
Banke	2007/08	19.6	151	15.0	256.9	271.9	3,082.9	1,502.1	1,580.8
	2008/09	19.4	148	16.9	221.1	238.0	3,095.4	1,629.6	1,465.8
	2009/10	18.7	142	13.9	205.2	219.1	3,283.3	1,792.0	1,491.3
	2010/11	56.25	448	N/a	N/a	325.50	N/a	N/a	N/a
	2011/12	63.63	503	N/a	N/a	330.1	N/a	N/a	N/a
	2012/13	84.43	679	N/a	N/a	N/a	N/a	N/a	N/a
Morang	2007/08	12.1	182	15.2	292.1	307.3	2,715.6	1,074.9	1,282.3
	2008/09	15.2	182	14.1	376.1	390.2	4,241.6	2,106.2	1,433.2
	2009/10	13.7	175	13.6	337.9	351.5	4,863.2	2,572.4	1,433.2

Note: 1 US$ = NRs 100

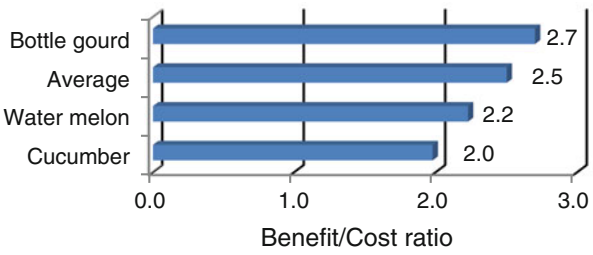


Fig. 7.3 Benefit-cost ratio of vegetable production in riverbed farming

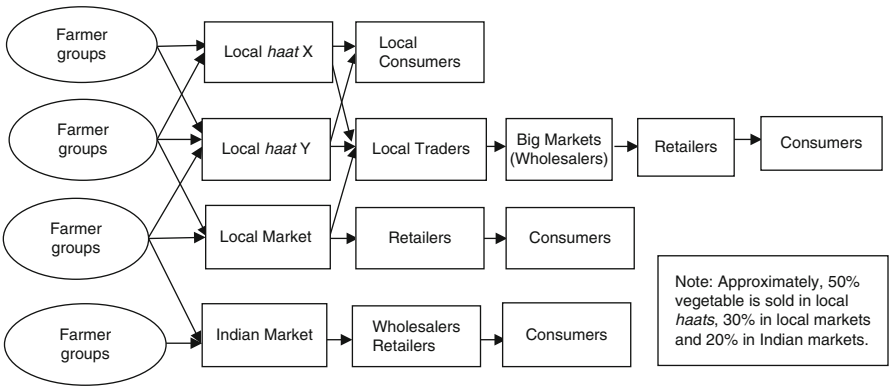


Fig. 7.4 Market mapping of fresh vegetables produced by riverbed farmers

it is expected that there will be market glutting and demand as well as prices will plummet. This will increase the risk of market failure and reduced profitability of vegetable farming. Therefore, a combination of 3–4 types of vegetable crops is a better option for smallholder riverbed farmers who are still dependent on local *haats* (periodical market) and small markets. Net profit from riverbed vegetable farming was carried out by farmers' group leader (ten farmers in each of the districts), as given in Table 7.2. The result shows that fertilizer and pesticides (40 %) and labor (38 %) are the major components in the total variable costs.

7.3.3 Development of Marketing Network

Vegetables produced on riverbeds need to be linked with the market to realize benefit by producers. Also to catch up the good price vegetables should be reached to the market timely. As discussed before, crops which are harvested early have higher demand and are sold at attractive prices as off-season vegetables. The market price trend analysis showed that vegetables, in March, were sold at NRs 20–25 per kg which later dropped to NRs 8–12 per kg during May/June. There is a weekly *haat* system at village level in the study area. *Haats* take place every day in the nearby

Table 7.2 Economic analysis of riverbed vegetable farming (area = 2 *Kattha* or 666 m^2)

Vegetable production cost (NRs)						Incomes from vegetables (NRs)					
SN	Description	Unit	Qty.	Rate	Total	SN	Description	Unit	Qty.	Rate	Total
A.	Variable cost					A	Incomes				
1.	Seeds					1	Income from sales				
	Water melon	G	40	5.8	232.0		Water melon	Kg	800	20.0	16,000
	Bottle gourd	G	15	5.0	75.0		Bottle gourd	Kg	800	20.0	16,000
	Cucumber	G	8	6.0	48.0		Cucumber	Kg	600	25.0	15,000
2.	Fertilizers										
	Compost	Q	10	400.0	4,000.0						
	Urea	Kg	12	26.0	312.0						
	DAP	Kg	8	54.0	432.0						
	Potash	Kg	6	42.0	252.0						
	Borax	Kg	0.5	200.0	100.0						
	Multiplex	Ml	75	2.0	150.0						
3.	Pesticides, hormone										
	Miraculan	ml	100	2.0	200.0						
	Pesticides	ml	300	3.0	900.0						
4.	Labor cost	Person days[a]	20	300.0	6,000.0						
5.	Land rent	*Kattha*	2	400.0	800.0						
6.	Marketing (transport)	Times in a season	6	400.0	2,400.0						
	Sub-total				15,901						
B.	Fixed cost										
	Depreciation on agriculture tools	lump-sum	–	–	300.0						
	Sub-total				300.0						
	Total cost (NRs)				16,201.0		Total income (NRs)				47,000
Net profit (NRs)											30,799

Source: Field survey 2012

Note: [a]Payment for wage laboring is done per person per day basis. In 1 day, wage laborer works for 7–8 h depending on the season and nature of the work

villages and farmers take advantage of this local market to sell fresh vegetable on regular basis. The participating farmers sell their vegetables in local *haats* which usually take place in the afternoon. Large number of women also participates in vegetable sales in local *haats*.

In the vegetable market chain, there were local traders who collect vegetables from *haats* and deliver them to different markets within and outside the district. Where the production sites are bordering India, large quantities of vegetables are exported to Indian market as well. Vegetables are put in locally made bamboo baskets for marketing. Bicycles and other means of transportation such as bullock drawn carts, public buses and jeeps are used for vegetable transportation to market centers. Farmers earn higher prices (NRs 2–5 per kg) for their produce in Indian markets compared to Nepalese markets if produced earlier. Some innovative farmers growing vegetables in larger area carry vegetables to nearby markets instead of selling to local traders in *haats*. In this regard, there are prospects of operating collective marketing system by riverbed vegetable producer groups linking into value chain with wholesalers in the big markets. A typical fresh vegetable market chain followed by producers and other market actors is shown in Fig. 7.4.

7.4 Lessons Learned

Cultivation of vegetables on riverbed is a potential approach to enhance socio-economic empowerment of marginal and landless communities. However, the productivity of vegetables grown on riverbeds is lower compared to normal land used for vegetable farming due to poor inherent soil fertility and risk of crop failure from various factors such as stray animals, flash flood, strong wind, and thieves. Also, the severity of the constraints varies with diverse geophysical settings. So, further action research about this practice is important considering the local specificity by government agencies and NGOs. Similarly, development of networking among the actors working on this practice could enhance this section further.

7.5 Conclusion

This chapter analyzes the potential and challenges of riverbed vegetable farming system. It is clear from the analysis that this system offers enormous potential to enhance the livelihoods of poor / disadvantaged communities residing nearby the riverbed areas. This system not only offers economic benefits to farmers, associated households are technically and socially empowered in agro-based livelihoods options as well. There is significant land area that can be put into riverbed farming and more and more farmers can be added every year as a result of extensive flooding. Among other vegetables, cucurbits are commonly grown on riverbeds. The seasonal nature of cropping, high level of plant nutrient requirements, problem of

stray animals, damage by strong windstorms, long spell of droughts and unexpected flood in winter are the major constraints to riverbed vegetable farming. On the other hand, vegetable farming on riverbed is easy in terms of land preparation, cultural practices and irrigation management; and it is therefore is an opportunity for landless and land poor families. Riverbed vegetable farming has emerged as a niche based on-farm income generation activity for landless and land poor families and well accepted by farmers and agricultural organizations. Joint efforts of government and non-governmental organizations are needed for scaling out this practice across the riverbed of Nepal.

Acknowledgements The authors wish to acknowledge the great efforts of farmers in riverbed vegetable farming and for providing qualitative and quantitative information to produce this paper. We would like to thank Mr. Ram Krishna Neupane, Program Director, FORWARD Nepal for his comments and suggestions on this paper.

References

Chapagai T, Pande DP (2006) Riverbed farming: technology and initiatives (in Nepali). FORWARD Nepal, Chitwan

Dhungel KR (2009) Nepal and climate change. www.nepalnews.com/home/index…/nepal-and climate-change. Accessed 8 July 2013

FAO (2007) Assessment of food security situation in Nepal. Special report, FAO/WFP Food Security Assessment Mission to Nepal, Food and Agriculture Organization, Rome

FAO (2008) Updates of food security in Nepal. Food and Agriculture Organization, Rome

Government of Nepal (GON) (2009) From Kathmandu to copenhagen: a vision for addressing climate change risks and vulnerabilities in the Himalayas. http://www.kathmandutocopenhagen.org/index.php. Accessed 10 June 2013

Helvetas Nepal (2010) Riverbed farming. http://www.helvetasnepal.org.np/rbf.htm. Accessed 5 July 2013

Maharjan KL, Joshi NP (2013) Climate, agriculture and rural livelihoods in the developing countries. Springer, Tokyo

NAPA (2010) Stocktaking report: agriculture and food Security. National adaptation program of action, thematic working group: agriculture and food security, Kathmandu

Piya L, Maharjan KL, Joshi NP (2012) Perceptions and realities of climate change among Chepang communities in rural mid-hills of Nepal. J Indian Comtemp India Stud Space Soc 2:35–50

Rai M (2007) Climate change and agriculture: a Nepalese case. J Agr Environ 8:92–95

World Bank (2007) Nepal at a glance. http://devdata.worldbank.org/AAG/npl-aag-pdf. Accessed 25 May 2013

Chapter 8
Income Generation Through People's Participation: Kitchen Gardening Practices of Three Marginalized *Bagdi* Villages in Bangladesh

Ashoke Kumar Ghosh and Keshav Lall Maharjan

Abstract The purpose of this chapter is to demonstrate how action research project is useful to empower resource poor communities taking a case of *bagdi* community of Bangladesh. A kitchen gardening project was implemented in three villages of *bagdi* community covering 83 households from 2009 to 2010. The project sensitized households about the importance of growing vegetables and fruit species in unused homestead through interactions, demonstrations and trainings. Findings show that kitchen gardening has contributed in increasing area, production and consumption of vegetables and fruits at household level. Households have also been able to increase cash income to some extent. More importantly, this project has been able to empower *bagdi* community for generating innovations about vegetable farming, which might have significant positive impact on livelihoods of farmers in the long run.

Keywords *Bagdi* community • Bangladesh • Kitchen gardening • Poverty reduction • Vegetables and fruits production

8.1 Introduction

Poverty reduction has been an overreaching goal of the Bangladesh government for last four decades. Acceleration of economic growth and agricultural development were adopted as poverty alleviation strategies in development plans (Ministry of

A.K. Ghosh (✉)
Department of Development and Poverty Studies, Faculty of Agribusiness Management, Sher-e-Bangla Agricultural University, Sher-e-Bangla Nagar, Dhaka 1207, Bangladesh
e-mail: ashoke1971@yahoo.com

K.L. Maharjan
Graduate School of International Development and Cooperation, Hiroshima University, Higashi-Hiroshima, Japan
e-mail: mkeshav@hiroshima-u.ac.jp

K.L. Maharjan (ed.), *Communities and Livelihood Strategies in Developing Countries*,
DOI 10.1007/978-4-431-54774-7_8, © Springer Japan 2014

Finance 2013). Although poverty has progressively declined during the period of 1990–2010, rural income inequality has steadily been increased over the same period. This state of affairs is attributable to economic, social, political, cultural, historical and institutional factors. Bangladesh has marginalized groups in its populace in different regions with divergent socio-economic, occupational and cultural characteristics. Most of the social safety nets and welfare programmes in national plans have addressed all categories of poor people as a homogeneous group.

Increasing the capacity of rural people to participate in decision making is considered prerequisite for success of any development projects (Okly 1991). People's participation in the development process has been overwhelmingly emphasized in other developing countries over the past few decades. Government, donors, development facilitators, academicians and policy makers have attributed the failure of rural development projects due to lack of participation of community people in needs assessment and problem identification. But the paradoxical situation is that in development programs, the major beneficiaries are elite groups who have better connection with political leaders or extension agencies. This creates income disparity among the rural population as richer section of the society becomes richer and vice versa. Policymakers or donors do not adequately include the perspectives and concerns of national stakeholders including intended beneficiaries in the decision making process (Qayum and Samadder 2013). Rural people's perceptions regarding problems and solutions are often overlooked, while their storehouse of information, experiences and analysis is usually neglected (FAO 2012). Moreover, there is lack of information how to implement the income generating activities in such communities for enhancing their livelihoods, combining technology, process and actors.

Considering 'participation' as a central mechanism of community development, an agro-based participatory action research, kitchen gardening project, was undertaken in *bagdi* community to enhance the family consumption, nutrition intake and income of the people. This project has distinct characteristic of reflecting the views and idiosyncrasies of all segments of the population, both the poor and the rich. This project was launched from 2009 to 2010. The objective of this chapter is to analyze how the disadvantaged marginalized *bagdi* community becomes empowered in vegetable and fruit farming through kitchen gardening action research project.

8.2 Development Plans and Programs for Poverty Alleviation

Article 15 of the constitution of the People's Republic of Bangladesh requires that the country pursues a path of sustained economic growth in order to realize its development objectives. In the four decades after Bangladesh gained independence in 1971, six Five Year Plans have been implemented. From 2003, Five Year Plans tend to focus more on the poor, which are being implemented through shorter term Poverty Reduction Strategy Paper (PRSP). Bangladesh is currently implementing its sixth Five Year Plan (2011–2015) prepared by the National Economic Council (NEC).

8.2.1 Five Year Plans

Bangladesh's national development strategies historically prioritized economic growth and poverty reduction. This was in line with the belief that economic growth would trickle down to vulnerable groups. It means mainstream poverty alleviation programmes supported all segment of the rural poor with the underlying assumption that extreme poor would benefit indirectly (Qayum and Samadder 2013). The first Five Year Plans (1973–1978) aimed to strengthen GDP growth and poverty alleviation. The approach here was to enhance employment generation through strong economic growth and distribution of basic goods at reasonable prices to the poor. The plan also incorporated issues of social welfare for a number of disadvantaged groups. The foremost concern of this plan was reconstruction and rehabilitation of the war devastated economy and support for war victims. In the Two Year Plan (1978–1980), top priority was given to economic growth through agriculture expansion through improved seeds, irrigation, fertilizer and credit. The second Five Year Plan (1980–1985) tried to address poverty reduction through rural development. Growth and equity through expansion of employment was expected to raise the income and purchasing power. For poverty alleviation, planners provided support to agriculture and agro-based industries as those would contribute to the development of the rural economy. The third Five Year Plan (1985–1990) considered poverty alleviation as a 'satisfaction of basic needs.' Income generation through creation of employment opportunities was considered as an element to reduce poverty. The plan provided very little incentives to the poor and disadvantaged groups. The overarching objective of the fourth Five Year Plan (1990–1995) was human resource development. Accelerating economic growth, alleviating poverty and generating employment through human resource development, self-reliance, reduction of population growth and women empowerment were central. During this period, a safety net program was adopted to take care of the needs of the poor. The main objective of the fifth Five Year Plan (1997–2002) was alleviating poverty through productive employment generation and bringing up at least half of the population above the poverty line. Other objectives were to develop socio-economic infrastructure, strengthen the safety net program, equity and development of backward areas, and reduce gender disparity and promotion of universal primary education. This plan had targeted number of groups under social safety net programs, such as old and disabled people, widowed and unemployed people. The objectives of the ongoing sixth Five Year Plan (2011–2015) are to reduce poverty by accelerating economic growth, sustained growth with equity, productive employment generation in the manufacturing sector, reduce income inequality and regional disparities, human development, digitize the country, diversify agriculture, ensure food security, increase enrollment of people at primary education level and reduce fertility rates. Although various programmes tend to tackle poverty, they, by and large, failed to realize that poverty alleviation programmes may not equally benefit all categories of the poor (Qayum and Samadder 2013).

8.2.2 Poverty Alleviation Programs

All United Nations' member states and at least 23 international organizations are expected to meeting the eight Millennium Development Goals (MDGs) by the year of 2015. The goals are to eradicate extreme poverty and hunger; to achieve universal primary education; to promote gender equality and empower women; to reduce child mortality rates; to improve maternal health; to combat HIV/AIDS, malaria, and other diseases; to ensure environmental sustainability and; to develop a global partnership for development. Out of the eight goals, first five are directly related to employment opportunity, income generation, awareness creation and food availability for people who are below the poverty line and do not own any land, vulnerable and destitute. To achieve those targets, the government of Bangladesh has a number of ongoing and newly introduced Poverty Alleviation Programs (PAPs). Priority was given to social safety net programs. The main objectives of those programs were to reach the poorest of the poor and to enhance their livelihood. Few other PAPs are Food for Work Program (FFWP), Vulnerable Group Development Program (VGDP), Road Maintenance Program (RMP) and Food For Education Program (FFEP). However, most of the programs could not achieve their desired objectives. Farid (2012) argues that the distribution of benefits from public spending at all levels of rural education has been rather regressive. The bottom 20 % of household received 13.8 % of public spending on rural education. In contrast, the top 20 % received 28.8 % of such rural expenditure. On the other hand, the largest public food distribution programs like FFWP and VGDP are predominantly relief operations and RMP is a mainly employment generation program which suffers from a relatively high level of program leakage.

Bangladesh has made reasonably good progress in its development indicators in recent years. The decline in poverty was more rapid in the 1990s than during earlier decades. Between 1991 and 2004, head count poverty declined from 58 % to 40 %. Net enrollment of primary education has also been rapidly increased from 60.5 % in 1991 to 91 % in 2007. However, rural income inequality has increased significantly during this period. It was also found that the gender equity has improved as the ratio of girls and boys in primary education was 0.83 in 1991, but has increased to 1.03 in 2007. Under-five mortality rate (per 1,000 live births) has reduced significantly from 146 in 1991 to only 67 in 2006. Maternal mortality ratio (per 100,000 live births) has improved as it reduced from 574 in 1991 to 348 in 2008.

However, the progress made on poverty reduction has been challenged. Macleod (2007) argues that the various international MDG monitoring sites have reported that between 1991 and 2000 Bangladesh's $1/day poverty rate rose from 36 % to 41 %, which is different from the claim of Bangladesh 2005 national MDG report. National poverty estimate in Bangladesh is on track to achieve MDG one, but Global Monitoring Agencies says poverty and inequalities are rising. This so called 'progress' might be only due to the people who are just below the poverty line have escalated up, but other majority of the excluded and vulnerable people are below the poverty line. Those people do not own any land and essential capital to invest to

make ends meet. Hence, any opportunity to use their existing homestead for fruits and vegetables cultivation will directly benefit them and contribute to alleviation of their poverty. Realizing this fact, Rural Development and Cooperative Division under the Ministry of Local Government, Rural Development and Cooperatives has launched a unique project titled 'Ektee Bari Ektee Khamar' (One house one farm) with a target of improving the welfare of rural people. Initially, the estimated cost of 5 year project was Taka (Tk) 11.97 billion (1 US $ = Tk 78.85), which was extended by four more years (2009–2013) with the budget of Tk 14.93 billion. The implementation phase of the project has already started and it will cover all 483 Upazilas (sub district) of the country (Paul 2012).

8.3 Kitchen Gardening and Poverty Alleviation

Vegetables and fruits production on small plots surrounding household compounds (backyard) have long been practiced not only in developing countries but also in many developed countries. This type of small scale farming is more effective in developing countries, because increasing numbers of small farmers are being marginalized by ecological, social and demographic forces (Midmore 1991). In addition, kitchen gardening practice might be a viable option to improve family nutritional status and to increase family income. Midmore (1991) notes that 10 % of the total household income of landless farmers in Bangladesh is earned from selling vegetables. And they also retain a sizeable proportion of their produce for family consumption. In Bangladesh, landless, marginal and small households comprises about 70 % of the rural population, with only 35 % of them have homestead cultivable land of 0.01–0.05 acres (Ghosh and Maharjan 2001). On an average, a landless farmer in Bangladesh uses 80 % of his earnings to buy rice and spend very little on other daily essential commodities. Considering varieties of their needs, they have a very little money to spend on vegetables and fruits. Nearly 40 % of the Bangladeshi population lives below the food consumption-based poverty line, with low purchasing power to afford diet of 2,122 kcal per person per day, along with other basic necessities. Apart from the prevailing deficit in total calories intake, the normal diet of Bangladeshis is seriously imbalanced with inadequate consumption of protein, fat, oil, fruits and vegetables and with more than 80 % of calories derived from cereals (Hossain et al. 2005). Women and children are especially more vulnerable to nutritional deficiency within the household (Yusuf Ali et al. 2008). Khan (2009) has also argued that in Bangladesh, per capita vegetable consumption is only 28 g against the daily requirement of 200 g. However, commercial farming by medium and large farmers has increased significantly since last decade. With comparatively higher profit and, improved communication and transportation systems, rich farmers are in a better position to produce vegetables commercially. On the other hand, kitchen gardening practice by poor farmers in Bangladesh is not well developed. Development practitioners including scientists, extension workers or even development agencies are ignorant about the fact that kitchen gardening is an integral part

of the family, culture and farming system in the rural areas. In many cases, the kitchen gardening "model" is introduced to farmers with specific measurement of plot size, and cropping patterns without considering local environment, existing farming practices, land structure and culture of the people.

8.3.1 Existing Studies on Kitchen Gardening in Bangladesh

Empirical studies show that the people who do not own cultivable land, but are engaged in kitchen gardening can still increase their income and family nutrition. Rahman (2008) has conducted a study on kitchen gardening and its contribution to food security in Bhaluka, Trishal and Gaforgaon Upazilas of Mymensingh district, Bangladesh. It was found that most of the respondents were middle aged having a small farm size and primary level education. Apart from increasing vegetable production and consumption, it was also reported that nutrient contribution from the vegetables through kitchen gardening fulfilled 100 % of Recommended Dietary Allowance (RDA) requirement of Vitamin A, Vitamin C and iron, including 87 % of calcium and 47 % of protein. It was found that majority of respondents practicing kitchen gardening earned satisfactory annual income. A similar research on kitchen gardening was conducted by Yusuf Ali et al. (2008) across different agro ecological regions of Bangladesh. He observed that, in most months of the year, farmers were able to fulfill their daily requirement of vegetables through kitchen gardening. Vitamin A and C requirements were met along with fulfillment of iron and calcium. Moreover, increased women's engagement in kitchen gardening enhanced their earnings. The author suggests that the nutritional education is crucial for mitigating nutritional deficiency and sustainability of vegetable gardening. Similarly, widespread dissemination of the kitchen gardening technology among the small farmers of Bangladesh through the mass media, development partners and NGOs is recommended. Another research was conducted by All-Mamun et al. (2010) on homestead vegetable cultivation, food security and income. A field survey was conducted at Raichow village, Comilla district to investigate the vegetables production and its impact on family nutrition, income generation and involvement of female members in this activity. It was found that highest number of farmers were marginal (44 %), followed by landless (28 %). The produce from kitchen gardening provides households with direct access to important nutrients that may not be readily available or within their economic reach. In addition, kitchen gardening increases the diversity of food, which in turn leads to improved balance of nutrients in household diets. An additional income generated from kitchen gardening is generally utilized to purchase additional food items which further increases the diversification of the diet. Finally, kitchen gardening is especially important in overcoming seasonal availability of foods and promotes household food self-sufficiency. Women are the main caretakers of the garden, which empowers them, ensures better utilization of the income from the garden for food and increases family welfare. All these benefits are important contributions towards poverty alleviation.

Hassan and Sultana (2011) conducted research on the topic 'food and economic security through homestead vegetable production by women in flood affected "Char" Land.' A total of 150 respondents were selected using simple random sampling technique. It was revealed that most of the respondents were illiterate. They had an average vegetable farmland of about 6.71 decimals and spend 3.20 h/day for cultivating vegetables in their homestead areas. Different type of vegetables like spinach, bitter gourd, cowpea, pumpkin, okra, water spinach and pointed gourd were grown during the summer season and red amaranth, brinjal, tomato, bean, radish and pepper during the winter season. These vegetables are available around the year even in the food insecure months such as March and September. A considerable portion of vegetables was consumed at home. They also earned some money by selling some of the vegetables which enhanced their economic security. The respondents of the study area faced some problems regarding kitchen gardening including lack of capital, lack of irrigation water and lack of good quality seeds.

Considering the importance of kitchen gardening as mentioned above, an action research project on kitchen gardening was implemented with the financial assistance of Research Initiative Bangladesh (RIB) from 2009–2010. All researchers under this project believe that when people use their own knowledge and wisdom to work towards a common goal, their efforts will be sustainable. The underlying premises of this interaction were: (a) not to impose any instructions on the community, (b) not to put forward any preconceived judgments, (c) to let them feel free in making their own discussion, (d) let them find their own problems, (e) let them be free to take initiatives, and (f) let them evaluate their own action and its outcomes.

8.3.2 Study Villages and Bagdi *Community*

Bangladesh has approximately 50 ethnic communities and many others who are marginalized. *Bagdi* is one of them and it is known differently in different places and regions. Somewhere they are called *munda*, and in some places they are called *buno* (living in the forest) and some other places they are known as *sardar* (hunter). Recently, these marginalized communities have achieved the status of *adibashi* (indigenous disadvantaged) in Bangladesh. Over the years, these communities have become more vulnerable due to social, economic and political deprivation. They are too powerless to defend themselves from discrimination, extortion, and injustice. They are neglected by the mainstream society and often considered as untouchable. As a result, they do not have access to productive resources, which limits their decision-making power. The social system is averse to their attainment of self-sufficiency. Traditionally, *bagdi* communities have been engaged in wage laboring and fishing in open water bodies for their livelihood. Few of them also used to engage in agricultural activities through clearing the lands covered by bushes. Occasionally, they also used to hunt wild animals and used to reside in forest areas. However, in the context of widespread deforestation and decreasing water bodies in

the countryside, these people became more vulnerable. Generally, the *bagdi* people do not own cultivable land except small homestead. They maintain their livelihood through wage laboring and other low paid jobs. Most of their earnings were used to buy rice and other essential food items. Sometimes, few households used their homestead to grow local fruits and vegetables. Low productivity and poor net return obtained from these species call for adopting well-planned homestead agricultural practice by combing traditional and high yielding technologies.

Additionally, too little income earned from wage laboring is not enough to support the whole family. Eventually, they cannot afford even three meals in a day. Parents cannot afford to send their children to school. Even if some children occasionally go to school, they are often not allowed to sit in the front bench or close to Muslim or Hindu students due to the social prejudice. Considering the overall situation, the action research project was implemented in the *bagdi* community with the aims; (1) to present a number of modern, high yielding homestead agricultural production technologies from which the *bagdi* members can select the appropriate ones to cultivate suitable fruits and vegetables all year round, (2) to enhance intake of vegetables and fruits for ensuring family nutrition for sustainable livelihoods and to increase cash income, and (3) to introduce group discussions through the formation of g*ono gobeshok* groups (People's Research groups) to promote the cultivation of fruits and vegetables at their homestead.

8.4 Methodology of the Study

Three *bagdi para*s were taken from three neighbouring villages, namely Johourpur and Telkup under Bagharpara Thana, Jessore district and Chakulia under Kaliganj Thana, Jhenidha district. Among the three *bagdi para*s Johourpur consists of 35 families, Chakulia 22 families and Telkup 26 families. All 83 families got kitchen gardening supports from the project, and selection of group members and crop species (fruits and vegetables) were done through active participation of farmers. Other strategies employed in capacity building of farmers in kitchen gardening were information dissemination about the importance of growing vegetable for cash income and household nutritional benefits through print media such as leaflet, supply of seeds, saplings and trainings for organizing kitchen gardening demonstration plots. It was hypothesized that these demonstration plots would serve as learning center for group members about various dimensions of kitchen gardening such as crop husbandry practices, insect and disease management. Household survey was carried out in all 83 households using structured questionnaire. To complement the information collected from household survey, key informant interview and group discussions with *bagdi* people were also organized in each village. Since the project was implemented through group approach, social capital developed in the group was assessed by observing the monthly group meeting minutes with reference to participation of members in the organization.

8.4.1 Research Process

The fundamental concept behind the action research is that research is done based on actual problem of intended beneficiaries/farmers in their active participation. It is believed that this process could play catalytic role to enhance innovation capacity of farmers through sensitization, demonstration and training, and technology dissemination. The process followed by this action research project can be discussed in the following three stages.

Stage 1: Sensitization

Initially, project staff visited in the *bagdi* communities and discussed on status of homestead lands, production and consumption of vegetables, opportunities and challenges in vegetable and fruit farming in the communities. The staff contacted with some local students and development workers working with *bagdi* communities and other similar communities in neighboring villages about the potential project activities to be implemented for enhancing livelihoods of these communities. The students and development workers also helped to get people together in respective villages to discuss issues concerning their livelihoods and agricultural activities. Gradually, they inculcated the habit of gathering by themselves in meetings. Later on, they fixed up a specific day in a week to get together and discuss their strategies that will help improve their livelihood. At the beginning, the authors wanted to make several groups in each village based on their geographical proximity and interests, and villagers agreed to be engaged in a group of 30 households. Then, the project facilitated the group about different dimensions of group actions including participation, information flow, leadership and record keeping. While discussing with the communities, it was found that community realized for the utilization of their homestead in efficient way for vegetables and fruits cultivation. Project staff displayed pictures of vegetables like tomato, beans and leafy vegetables which can be produced all round year and importance of these vegetables for economic and family nutrition.

Stage 2: Demonstrations and Trainings

Once the farmers became aware about the potentials of growing vegetables and fruit species in the first phase, *bagdi* community members were supported for organizing demonstrations for the production of different vegetable and fruit varieties. Villagers organized in groups were informed about different types of existing homestead vegetable production models, such as, Kolikapur, Lebukhali, Kolapara, Tangail, Att Kopalia, Rangpur, Borendra and Faridpur (Bangladesh Agricultural Research Institute (BARI) 2006a, b). However, villagers felt difficulties in understanding these models. Most of the existing vegetable production models such as Kolikapur

Fig. 8.1 A small plot mixed vegetables in *bagdi* village

model suggested that kitchen garden field should be 6×6 m and selected space should be upland with all sides open. Similarly, Kolapara model suggested field size of 5×5 m with five vegetables beds and the selected vegetable varieties should be cultivated in different seasons. Some households argued that existing shape and size of homestead does not allow farmers to adopt these models, and some others raised concerns about the choice of varieties. So, the project gave flexibility in choosing crop varieties (improved vs. local) and plot size (large vs. small), but emphasis was given for using locally available material and traditional knowledge for soil management. The farmers were encouraged to combine a numbers of vegetables and fruits varieties developed from farmers' innovations and agricultural research organizations. For example, hybrid tomato varieties, *bait sake*, *gamma kalmia* and some other open-pollinated tomato varieties were demonstrated. In this process, project supported only seeds and technical knowledge and all other inputs were contributed by farmers. Using the tomato seed received from project, farmers planted tomato in inter cropping system with beans and crucifers (Fig. 8.1).

Moreover, the project supported group members to prepare annual cropping calendar for producing vegetable and fruit species considering how farmers could best utilize their land considering crop diversification, seasons, pest management, and availability of vegetable all-round the year. The annual cropping calendar also shows which crop to plant in which direction to best utilize the sun light, and shade in accordance with crops' requirement. For example, cucurbits are generally planted in the boarder whereas leafy vegetables towards the shade.

Stage 3: Technology Dissemination

The project organized periodic monitoring in the demonstration plots to understand the potentials and challenges faced by *bagdi* communities in the management of

Fig. 8.2 A small plot of kitchen garden with tomato and brinjal in *bagdi* village

kitchen gardening. The project also organized farmers' field days to demonstrate the kitchen garden technology among the neighbors. These events served as a platform to disseminate the knowledge farmers learnt from demonstrations about kitchen gardening (Fig. 8.2). Moreover, at the end of each crop cycle, the project organized group discussion to document achievements, learning and problems faced by members in kitchen gardening. Discussion was also made about the seed saving at local level so that farmers' preferred varieties found suitable in kitchen gardening could be widely scaled out through informal contacts. Experts from agricultural research stations visited demonstration plots, and they asked the farmers that farmers could visit the stations if they need more seed and associated technical information.

8.5 Results and Discussion

This section is divided into three parts. First, we will summarize the socio-economic characteristics of *bagdi* community members, second part will compare the changes in vegetable production and consumption before and after the project implementation, and third section summarizes the major lessons learnt from this action research.

8.5.1 Socio-Economic Characteristics of the Bagdi *Households*

Bangladesh is an agrarian country and the majority of the people depend directly or indirectly on the agricultural sector for their livelihood. Land is one of the most

Table 8.1 Farm categories in studied *bagdi* villages and Bangladesh

		Farm categories			
Villages	No. of household	Landless	Small	Medium	Large
Johourpur	35	88.57	8.57	2.86	0
Chakulia	22	82.60	17.40	0	0
Telkup	26	80.77	19.23	0	0
National level	–	38.62	49.86	10.34	1.17

Source: Field survey 2011 and Statistical Pocket Book Bangladesh 2008
Note: Landless farm is with 0.0–0.49 acres of land, small farm is with 0.50–2.49 acres of land, and medium farm is with 2.50–7.49 acres and large farm with 7.50 acres of land and above

Table 8.2 Level of education among the population of 20 years and above in studied villages

	Level of education				
Villages	Only signature (<V)	V–IX	X–XII	Above XII	Total (%)
Johourpur	29.60	16.32	7.14	2.04	55.10
Chakulia	20.60	13.07	2.11	0.00	35.78
Telkup	22.35	10.37	5.77	0.00	38.49

Source: Field survey 2011

valuable assets in rural Bangladesh. Education and occupational status are also determining factors of socio-economic status among rural population. Characteristics of *bagdi* households in the studied villages are summarized below.

Land Holding

Patterns of land holding in selected villages indicate that majority of *bagdi* households are landless. Table 8.1 shows that 89 %, 83 % and 81 % of the *bagdi* households in Johourpur, Chakulia and Telkup, respectively are landless. These figures are quite higher than that of national statistics for landless (39 %) in Bangladesh. Similarly, lower percentage of *bagdi* households fall under small farm category than that of national figures across the selected villages. This above analysis implies that majority of *bagdi* families are landless and there is, thus, the need for alternative income generation or supplementary earning options.

Education Level

In general, the literacy rate is very low in Bangladesh and it is much lower among the ethnically marginalized communities. Table 8.2 shows the education level in *bagdi* villages. A significant percentage of the population aged over 20 years can only sign their name. This category of people constitutes 30 %, 21 % and 22 % of the population of Johourpur, Chakulia and Telkup, respectively. Similarly, a lower

Table 8.3 Occupational structure of the studied villages

Occupational category	Johourpur	Chakulia	Telkup
Farming	51.43	34.38	48.57
Laboring	17.14	28.72	24.72
Services/business	8.57	3.58	9.35
Van pulling	14.29	22.20	9.23
Shop keeping	2.86	3.58	5.07
Others	5.71	7.54	3.06
Total	100.00	100.00	100.00

Source: Field survey 2011
Note: Although majority of the *bagdi* families are landless, many of them do farming by leasing or mortgaging in land from neighboring land owner farmers

percentage of the population attained class V–IX as it is 16 %, 13 % and 10 % for Johourpur, Chakulia and Telkup, respectively.

Only 2 % of the household members in Johourpur are above XII. Taking those who can at least sign as being educated, it is only 55 %, 36 % and 39 % in Johourpur, Chakulia and Telkup, respectively.

Occupation

Due to the unavailability of job and low level of incomes, rural people try to find different types of alternative income sources. Although most of the *bagdi* families are landless, farming is their predominant occupation. Land poor *bagdi* families try to mitigate the land shortage problem through sharecropping and leasing or mortgaging land from neighboring rich farmers. Table 8.3 shows the occupational structure of the *bagdi* households in the studied villages. In Johourpur, 51 % of the households have taken farming as their major occupation. A significant portion (17 %) is engaged in wage laboring. Only about 9 % are engaged in the service sector. Again a significant number (14 %) has taken *van* pulling as their main occupation. A small proportion (3 %) is engaged in shop-keeping and 6 % is engaged in other jobs as their main occupation.

Similarly, in Chakulia, about 34 % are taking farming as their main occupation followed by 29 % in wage laboring, while service, van pulling, shop-keeping and other engagements were about 4 %, 22 %, 4 % and 8 %, respectively. In Telkup, 49 % has taken farming as their main occupation, and 25 % as wage laboring. About 9 % are engaged in service/business and same (9 %) percentage of the population was engaged in van pulling. Few people (5 %) were engaged in shop keeping and other occupations (3 %).

Income

Households' monthly income in *bagdi* community is quite lower than the average monthly income of Bangladeshi households. Table 8.4 shows the distribution of

Table 8.4 National rural and *bagdi paras* monthly income distribution in Taka (Tk)*

Income group	National households (%)	Households in *bagdi* villages (%)
Less than 2,499	9.71	49.00
2,500–4,999	26.77	45.71
5,000–7,999	24.22	3.43
8,000–12,499	18.60	1.86
12,500 and above	20.70	0.00
Total	100.00	100.00

Sources: Field survey 2011; Report of the household income and expenditure survey (2010)
Note: Income range is modified considering the purpose of study; 1 US $ = 78.85 Taka (Tk)

households under different income categories at national level and *bagdi* communities. The data reveals that higher proportion (49 %) of the households in *bagdi* villages fall into the lowest income group with monthly income less than Tk 2,499. However, the proportion of household falling under this income group is less (9.71 %) than that of the *bagdi* community and this implies that poverty is a more serious issue in *bagdi* villages as compared to overall situation of Bangladesh.

If we consider the middle-income group (Tk 5,000–7,999), we can see that the proportion is much less for *bagdi* (3 %) households compared to the national data (24 %). Again, only about 2 % of the *bagdi* households fall under the higher income group (Tk 8,000–12,499) compared to the national data (19 %). None of the b*agdi* families are found in the higher income group (Tk 12,500 and above). The result is a clear demonstration of the poor economic status and vulnerability of *bagdi* people.

8.5.2 Outcomes of Action Research Project

Adoption of Different Vegetable and Fruit Crops

The adoption of this cropping calendar (Fig. 8.3) would be useful for households in utilizing their homestead in an efficient way and in supplying vegetables and fruits all-round the year.

This study shows that number of adopters for kitchen gardening has increased by 2.5 times after project implementation. The study shows that after 2 years project cycle, project participants have started adopting diversified vegetable and fruit crop varieties in their homestead. Figure 8.3 shows the common annual cropping calendar adopted by households across the Johourpur, Chakulia and Telkup though there is quite variation in the composition of fruits and vegetable varieties adopted by households across the villages. This means that kitchen gardening is not a new in the project area; some of the households had adopted this practice for a long time but now cropping intensity in their homestead has increased. This is supported by increased vegetable production in the study area (Table 8.5). Moreover, outcome of the project is better in Johourpur as compared to other two districts.

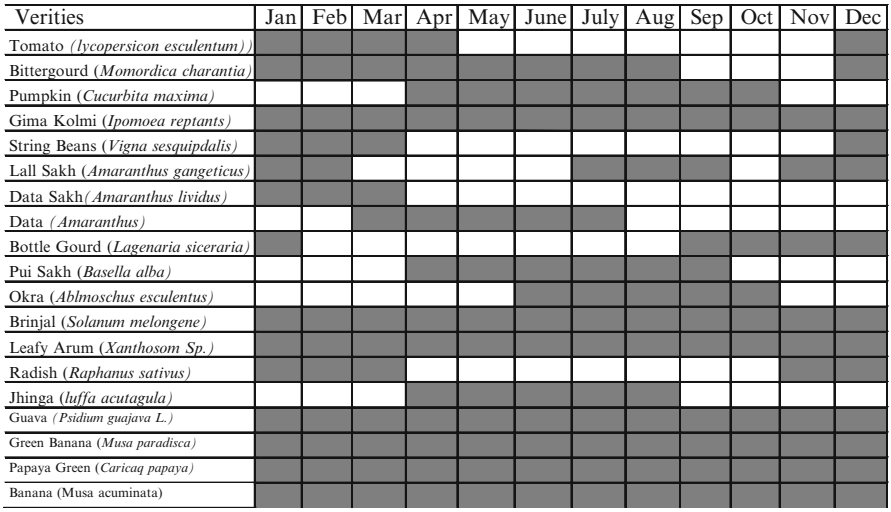


Fig. 8.3 Vegetable and fruits grown in the study area in a year. *Source*: Field survey 2011. *Note*: *Shaded months* indicates crop standing and *blank months*, fallow

Vegetable Production and Consumption

The implementation of the kitchen gardening project has substantially increased the earnings of *bagdi* households in studied villages though the sale of vegetables and fruits. They cultivated tree crops like banana, papaya and guava which can provide fruits and earnings for couple of years. Table 8.6 shows that on an average a household from Johourpur village produces 390 kg of vegetables and fruits of which 210 kg is used for family consumption and the rest (180 kg) is sold in the local market. Similarly, a household in Chakulia produces 267 kg of vegetables and fruits of which 143 kg is used for family consumption and the rest (124 kg) is sold to earn income for the family. In a similar manner, a typical farmer from Telkup produces 225 kg of fruits and vegetables of which more than half (121 kg) is consumed and the rest (104 kg) is sold in market. Consequently, farmers, on average, earn Tk7,800 in Johourpur, Tk 5,340 in Chakulia and Tk 4,500 in Telkup from kitchen gardening.

Share of Income from Vegetables and Fruits Production

The study shows that income from kitchen gardening shares very small portion (12.5 %) of households' annual cash income (Table 8.7). Households in Johourpur village earn about 14 % of annual income through kitchen gardening. Similarly, a farmer from Chakulia and Telkup earns 12 % of total income from kitchen garden. The total annual income was highest for Johourpur (Tk 48,390) which is followed by Chakulia (Tk 44,475) and Telkup (Tk 38,700). The share of low cash income

Table 8.5 Number of vegetables and fruits producing households and their average production before and after implementation of the project

Villages	Total number of households surveyed	Number of HHs in the sample			
		Before project		After project	
		No. of HH	Production	No. of HH	Production
Johourpur	35	11	139	32	390
Chakulia	22	8	109	19	267
Telkup	26	9	116	23	225
Total	83	28	121	74	294

Source: Field survey 2011

Table 8.6 Yearly vegetables fruits productions (kg) and gross return

Villages	Vegetable and fruit production	Family consumption	Marketed vegetable	Estimated earnings (Tk)
Johourpur	390	210	180	7,800
Chakulia	267	143	124	5,340
Telkup	225	121	104	4,500
Average	294	158	136	5,880

Source: Field survey 2011

Table 8.7 Share of income through kitchen gardening

Villages	Households' annual income	Share of income from vegetable cultivation (%)
Johourpur	48,390	13.85
Chakulia	44,475	12.01
Telkup	38,700	11.63
Average	43,855	12.50

Source: Field survey 2011

from vegetable farming is due to the production of vegetables in small land size. The share of vegetable income to the total annual households' cash income could increase after few years because drawing on the lessons /innovations from kitchen gardening farmers could increase area under vegetable production and increase the production efficiency of vegetable farming.

Changes in Vegetables and Fruits Consumption

Farmers tend to consume more vegetables if there is adequate quantity of vegetables and fruits at their homestead. Table 8.8 shows that farmers in all *bagdi* villages consumed more vegetables and fruits after implementing the kitchen gardening project. Before the project, per capita daily vegetable and fruit consumption in Johourpur was only 62 g which increased to 111 g after implementing the project. Similarly, per capita vegetable and fruit intake has increased from 41 to 77 g in Chakulia and 34 to 68 g in Telkup.

Table 8.8 Vegetables and fruits consumption before and after implementation of the project

	Vegetable and fruit consumption	
Villages	Before the project (g)	After the project (g)
Johourpur	62.22	111.28
Chakulia	40.67	76.82
Telkup	34.22	67.65
Average	45.70	85.25

Source: Field survey 2011

8.5.3 Lesson Learnt

Action Research Enhances Innovation

In the project area seeds of some crop varieties were supplied by project. However, some crop varieties (such as hybrid variety of lady finger) did not germinate properly. Farmers tried to dig out reasons behind it and found that poor germination was observed in water logging places and realized that this problem was due to poor land management. They continued to identify crop varieties that can withstand heavy rain and found out varieties of lady finger (especially local varieties), *gima kolmi,* arum*,* green banana and papaya suitable for growing in rainy season. Moreover, farmers found that *gima kolmi* and papaya green can be harvested for 2 years, and leafy arum can be harvested for a decade. Hence, the farmers have started planning their cropping calendar and management practices incorporating their practical knowledge and experiences.

Action Research Leads to Technology Dissemination

Households participating in the demonstrations saved the seeds of crop varieties they liked. From the next seasons they started growing vegetables using such saved seeds of different crops such as spinach, pumpkin, beans, bottle-gourd, brinjal, and *lall sakh*. Some other vegetable seeds were collected or bought locally by farmers themselves during the project period as they were motivated to find out something new for their own efforts. Many farmers, especially women, distributed their excess seeds to neighboring farmers across Hindu and Muslim as well as *rishi* (cobbler) and fishing communities.

8.6 Conclusion

This chapter analyzes the outcomes of kitchen gardening implemented in the *bagdi* community of Bangladesh in action research model. People of this community are poor economic status and low education level, and mainly make their livelihoods

from share cropping. Though project period was short and detail impact of the project is yet to be documented, it is clear from the analysis that kitchen gardening is useful to increase availability of vegetable and fruit consumptions and cash income at household level in poor and marginal community. Moreover, action research modality in kitchen gardening empowers farmers in generating innovations. Process and outcomes from this action research project could serve as an example agricultural research and development agencies intended to enhance food and nutritional security in resource poor communities of Bangladesh and other similar developing countries.

References

All-Mamun MH, Bashar HMK, Islam MS, Howlader MHK, Hasan MS (2010) A case study on homested vegetable cultivation: food security and income. Int J Sustain Crop Prod 5(1):5–10

Bangladesh Agricultural Research Institute (BARI) (2006a) Agricultural technology manual, 1st part, 4th edn. BARI, Joydevpur, Gazipur

Bangladesh Agricultural Research Institute (BARI) (2006b) Agricultural technology manual, 2nd part, 4th edn. BARI, Joydevpur, Gazipur

Bangladesh Bureau of Statistics (2008) Statistical pocket book. Planning Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka

Bangladesh Bureau of Statistics (2010) Report of the household income and expenditure survey. Planning Division, Ministry of Planning, Government of the People's Republic of Bangladesh, Dhaka

FAO (2012) Participatory rural communication appraisal: communication for development in action. http://www.fao.org/docrep/008/y5793e/y5793e03.htm#TopOfPage. Accessed 8 Sept 2013

Farid SM (2012) Rural poverty alleviation under changing economic conditions: Bangladesh perspectives. http://www.unescap.org/rural/doc/beijing_march97/bangladesh.PDF. Accessed 16 Sept 2013

Ghosh AK, Maharjan KL (2001) Impacts of dairy cooperative on rural income generation in Bangladesh. J Int Dev Coop 8(1):91–105

Hassan SS, Sultana S (2011) Food and economic security through homestead vegetable production by women in flood affected "char" land. Sci J Krishi Foundation 9(1 and 2):44–45

Hossain M, Quazi S, Naher F (2005) Food security and nutrition in Bangladesh: progress and determinants. J Agr Dev Econ 2(2):103–132, www.FAO.org/es/esa/eJaDE. Accessed 9 Sept 2013

Khan MAH (2009) Year round homestead vegetable production: a means of reducing poverty and nutritional deficiency for small farm. Bangladesh J Agr Res 34(1):44–53

Macleod D (2007) Is poverty increasing in Bangladesh? Reconciling national and global monitoring estimates. Final draft, Consultant of UNDP-BDP Poverty Group and the UNDP BCRP, Fordham University, New York

Midmore DJ (1991) Household gardening project in Asia: past experience and future directions. Asian Vegetable Research and Development Center, Technical Bulletin -19, AVRDC Publication, Taipei

Ministry of Finance (2013) Poverty alleviation. http://www.mof.gov.bd/en/budget/12_13/ber/en/chapter-13_en.pdf. Accessed 10 Sept 2013

Okly P (1991) Project with people: the practice of participation in rural development. International labor organization, Geneva International labor office, Geneva

Paul S (2012) Ektee bari ektee khamar: a dream project. The financial express. English daily newspaper in Bangladesh. City Publishing House Ltd, Dhaka

Qayum N, Samadder M (2013) Eradicating extreme poverty in Bangladesh: national strategies and activities, vol 58, Research monograph series. Research and Evaluation Division, BRAC, Dhaka

Rahman FMM (2008) Food security through homestead vegetable production in the smallholder agricultural improvement project (SAIP) area. J Bangladesh Agr Univ 6(2):261–269

Yusuf Ali M, Mustaque Ahmed M, Badirul Islam M (2008) Homestead vegetable gardening: meeting the need of year round vegetable requirement of farm family. Paper presented in the national workshop on multiple cropping held at Bangladesh Agricultural Research Council, Farmgate, Dhaka on 23–24 April 2008. On-Farm Research Division, Bangladesh Agricultural Research Institute, Gazipur

Chapter 9
Post Mount Merapi Eruption Recovery of Smallholder Dairy Farming: A Case Study of Disaster Management in Indonesia

Mujtahidah Anggriani Ummul Muzayyanah, Suci Paramitasari Syahlani, Yuni Suranindyah, and Fransiskus Trisakti Haryadi

Abstract Majority of dairy farmers in Indonesia are small-scale. These farmers face challenges of land scarcity, limited farmer education, low dairy cow productivity and profitability, and low milk quality. Over 80 % of total dairy cattle in Daerah Istimewa Yogyakarta (DIY) Province are in Mt. Merapi valley area. The volcanic eruption in 2010 damaged dairy farms mostly caused by hot smoky ash clouds and flowing lava. Death of cows resulted in reduced milk production in the region. Dairy farmers' groups in this area played an important role in the disaster recovery processes. Before the disaster, dairy farmers' groups had relationship with only cooperatives. After Mt. Merapi disaster in 2010, the dairy farmers' groups joined Merapi Mandiri Gabungan Kelompok Tani (GAPOKTAN), which has the leverage to facilitate government assistance to farmers. GAPOKTANs were established to help solve smallholder farmers' challenges in farm management including lack of access to government services, financial problems, difficult on milk marketing, unavailability of far inputs, and lack of access to knowledge and technology. GAPOKTANs play an important role in improving smallholder dairy farming management in a sustainable way. Through GAPOKTANs, government financial assistance was channeled to members of farmers' groups which are affiliated to GAPOKTANs which helped immensely farmers' recovery from Mt. Merapi disaster.

Keywords Dairy farming • GAPOKTANs • Mt. Merapi disaster

M.A.U. Muzayyanah (✉) • S.P. Syahlani
Livestock Agribusiness Laboratory, Faculty of Animal Science, Gadjah Mada University, Yogyakarta, Indonesia
e-mail: m_anggriani_um@ugm.ac.id

Y. Suranindyah
Dairy Science and Milk Industry Laboratory, Faculty of Animal Science, Gadjah Mada University, Yogyakarta, Indonesia

F.T. Haryadi
Extension and Communication Development Laboratory, Faculty of Animal Science, Gadjah Mada University, Yogyakarta, Indonesia

K.L. Maharjan (ed.), *Communities and Livelihood Strategies in Developing Countries*,
DOI 10.1007/978-4-431-54774-7_9, © Springer Japan 2014

9.1 Introduction

Dairy farming in Indonesia is dominated by small-scale farmers with herd size of less than four (80 %). Only 17 % of farmers own between four and seven cows while only 3 % of farmers own more than seven cows. In the same vein, smallholder farmers also contribute about 64 % of national milk production, and about 28 % and 8 % is produced by the medium dairy farming enterprises and large scale dairy companies, respectively (Erwidodo 1998; Swastika et al. 2005).

Reports from Directorate General of Livestock (DGLS) show that dairy cattle in Indonesia are raised in 19 out of the 33 provinces. However, about 97 % of all dairy cows are located in the three provinces of East Java (47 %), Central Java (25 %) and West Java (25 %) (DGLS 2012). Apart from these three provinces, Daerah Istimewa Yogyakarta Province (here after DIY Province) is the next most productive region in terms of milk production with 3,167 t in 2011 and dairy cattle population of 3,522. Among five regencies in DIY Province, Sleman regency is the center of cattle milk production in DIY Province (Fig. 9.1). The population of dairy cows in 2000 was 4,069 with a total milk production of 6,888 t. Out of this number, 3,744 cows

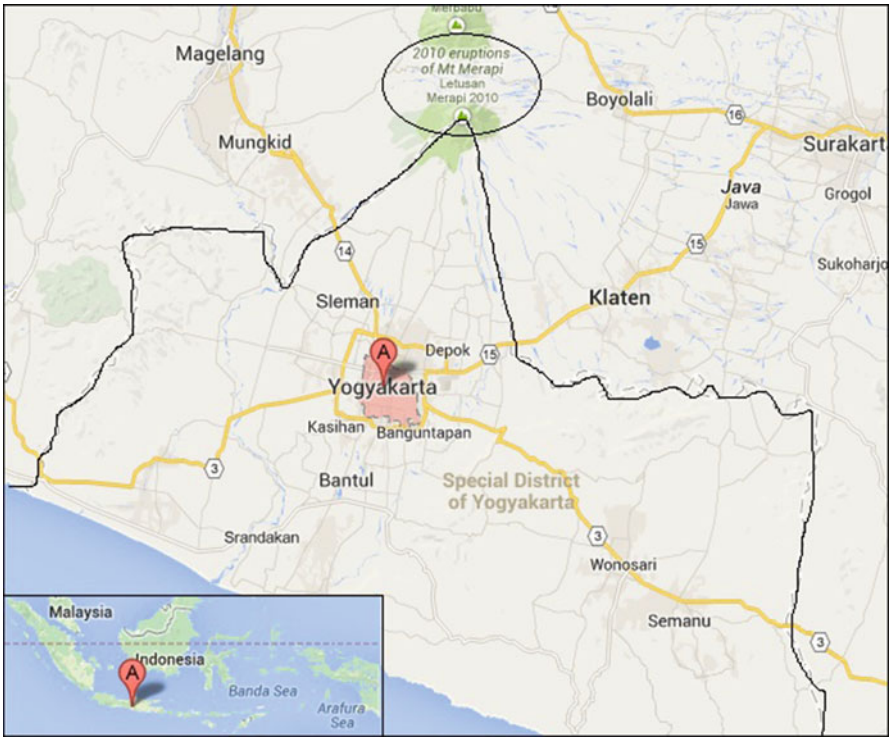


Fig. 9.1 Map of DIY province. *Source*: http://maps.nationalgeographic.com

(92.01 %) were located in the district of Merapi Valley area, producing 92 % of total cattle milk in DIY Province (DIY Provincial Livestock Office 2012).

Mt. Merapi, one of the world's most active volcanoes with a peak of 2,968 masl, is located in a densely populated area in Central Java. The mount covers up parts of three regencies in Central Java (Magelang, Klaten and Boyolali) and Sleman regency in DIY Province. The villages around the slopes of Mt. Merapi have fertile soils which lure people/farmers into this area. It also has abundant water resources and ecosystems suitable for agricultural activities. The people are engaged in estate, horticultural, and pastoral farming. But they are plagued with periodic eruption of Mt. Merapi. As of November 2010, 43 volcanic eruptions had been recorded. The eruption of Mt. Merapi in 2010 is, so far, the largest. The hot ash clouds went down the slopes as far as 13 km and the explosion was heard 20 km away from the epicenter. The explosion on November 4–5, 2010 was the most powerful in the 2010 series of eruptions that started at the end of September 2010. The eruption caused huge damage to the land and sent residents streaming down the mountain with ash-covered faces. More than 100 people were killed and an estimated 75,000 residents were evacuated. The eruption caused serious damage to physical infrastructure including farmlands and water installations. Ashes from the volcano destroyed plants and poisoned livestock feed. Hundreds of hectares of farmland for horticultural activities were also destroyed leading to financial losses among farmers. Food processing units and government and private-sector enterprises got wrecked, and so there was less incentive for traders to buy farm products.

Even though it is a hazardous area, villages around the slopes of Mt. Merapi have fertile soils which attract many farmers. It is therefore not surprising that the occupation of majority of the people is agriculture. The area has resources and ecosystems which are suitable for agriculture activities including dairy cattle farming, but ash clouds destroyed plants and poisoned livestock. Hundreds of hectares of land under horticultural cultivation were damaged leading to huge financial losses among farmers. Government and private-sector stores and processing units as well as home-based enterprises were also damaged, leading to hesitation among traders and consumers to buy farm products because of health safety concerns among other factors. The government, through the National Disaster Management Agency (BNPB), provided support to people who were affected by the volcano. Government promised to buy all the cattle from farmers in the affected villages to keep people from going back to their homes during the crisis period. In return, the government set aside some funds for disbursement to affected farmers so that they could replace their livestock. The government noted that farmers faced uncertain market conditions which would worsen through natural disasters (Sutherland and Glendinning 2008). People living on the valley, particularly dairy farmers are the middle-class who will plunge into poverty if there is a natural disaster (Hewitt 1983; Taiban 2013). With this understanding, government proceeded to evacuate families as a precaution and to minimize losses from the eruption. The evacuation process was not smooth because it was not fully accepted by all the farmers. Livestock evacuation was rejected by the large-scale farmers as they could not be assured of livestock housing and feed supply facilities in their destination (Andarwati and Haryadi 2010).

Alternatively, authorities can relocate residents away from place where there are recurrent disasters, but due consideration of land, culture, memories, and livelihoods is important to make it successful (Taiban 2013). In case of Mt. Merapi, relocation is not appropriate choice because people in Mt. Merapi Valley area insisted that they would be staying in their place of settlement and not leave their livelihood, even though the eruption of Mt. Merapi caused huge destruction in the area. Different policies and strategies would be required to deal with social, economic and culture issues involved in order to bring people's life back to normal.

9.2 Dairy Farming in Sleman Regency

Dairy farming in DIY Province is practiced in four regencies and one municipality: Bantul, Gunung Kidul, Kulonprogo, Sleman regency, and Yogyakarta Municipality (Fig. 9.1). The Sleman regency is located between latitudes 7°32′–7°50′ and 110°18′–110°35′ Longitude. The capital of Sleman regency is Beran, which is in the southwest side of the Mt. Merapi. It is the most important area of dairy farming in the province. Fourteen of 17 districts in Sleman regency are small scale dairy farming area. More than 90 % of dairy cattle population in DIY Province is in Sleman regency (Table 9.1).

Sleman regency has wet tropical climate with a rainy season from November to April, and a dry season from May to October. The relative humidity is lowest (74 %) in August and highest (87 %) in March and November. The minimum and maximum temperatures are about 26 °C and 27 °C, respectively. These agro-climatic conditions indicate that the climate of Sleman regency is suitable for agriculture including dairy farming. Livestock Statistics of DIY Province shows that the number of dairy cattle in DIY Province increased from 4,917 in 2002 to 8,212 in 2005. The cattle population, however, declined over the period 2006–2010 because of

Table 9.1 Dairy cattle population in DIY province (Heads)

	Regency/municipality					
Year	Yogyakarta city	Bantul	Kulonprogo	Gunung Kidul	Sleman	DIY province
2002	62	183	56	95	4,521	4,917
2003	64	172	66	0	6,343	6,645
2004	46	164	60	0	7,502	7,772
2005	38	176	27	0	7,971	8,212
2006	41	181	24	0	6,985	7,231
2007	28	171	16	7	5,589	5,811
2008	27	129	24	7	5,465	5,652
2009	26	130	68	6	5,265	5,495
2010	21	192	113	6	3,134	3,466
2011	26	212	122	6	3,522	3,888

Source: DIY Provincial Livestock Office 2012

natural disasters in 2006 (earthquake and Merapi eruption) and 2010 (Merapi eruption). The decline in dairy cattle population in Sleman was reversed after Merapi eruption disaster. In 2011, dairy cattle population reached 3,888 heads in DIY and about 90 % of the population are in Sleman regency. This is attributable to government program to allocate funds allocation for replacement of cattle affected by Merapi eruption.

In general, dairy farming system in Indonesia, particularly Sleman regency, is small scale activity with 2–3 cattle and with a conventional feeding and milking system. Cattle feed consists of 60 % forage (dried rice stalks, sugarcane leaves, *lamtoro* leaves, grass, corn leaves, potato leaves and green bean leaves) and 40 % concentrate. Generally, feed is given twice a day in the mornings and evenings. Concentrate and forage are given before and after milking, respectively. Sources of carbohydrates in cattle feed are refined rice bran or bran, tofu waste, dry cassava and coconut cake. Most dairy cattle in Indonesia are Friesian Holstein and Jersey breeds. Livestock breeding is organized by farmers in groups, known as Village Breeding Center (VBC). VBC is still the most reliable supplier of breeding stock, both dairy cattle and other livestock (beef cattle, buffalo, goats, sheep, pigs, chickens and ducks). Government has allocated funds to support the breeding activity in VBC, especially to enhance farmers' participation in the livestock breeding in order to increase the local breeding stock.

Most individual (smallholder) farmers are members of local dairy associations known as dairy farmers' groups. Farmers form groups because they have limited resources. The smallholder dairy farmers' groups in DIY Province were established with the twin objectives of delivering efficient dairy development extension services, and assisting dairy farmers to enhance their income and attaining dairy development goals. These groups offer smallholder farmers support through collective action to secure inputs such as animal feed, milking tools and veterinary services, and improved market opportunities. Farmers in groups encourage each other to adopt efficient farming practices. It is not therefore surprising that most livestock farming activities/practices are outcomes of group decisions. Group membership also serves as a vent for sharing farming knowledge, and technology. It is also organized in such a way that it is in harmony with the culture of mutual cooperation, especially among Merapi disaster victims.

9.3 Impact of Mt. Merapi Eruption Recovery Strategy in Dairy Farming

The eruption of Mt. Merapi in November 2010 is the most explosive in living memory, causing immeasurable damage to farm facilities and livestock. Impacts of the disasters on dairy farming are presented in Table 9.2. Cattle population reduced by 44.37 %, result from death or low motivation on the part of farmers to keep livestock. This is a critical issue that needs to be addressed since the area is a center of milk production in DIY Province. The impact of the disaster was visible not only

Table 9.2 Impact of Mt. Merapi disaster on dairy farming in Sleman regency

Cooperative	Cattle population before disaster			Eruption impact (number of cow)			Cattle population after disaster	Revenue losses (IDR '000)
	Cows	Others	Total	Death	Burns	Sold		
Warga Mulya	800	400	1,200	22	–	100	1,078	1,414,692
Sarono Makmur	750	750	1,500	1,300	–	100	100	10,887,550
UPP Kaliurang	1,543	1,741	3,284	1,059	24	50	2,151	8,673,384
Total	3,093	2,891	5,984	2,381	24	250	3,329	20,975,626

Source: Ilham and Priyanti 2011

Note: Cows refer to both lactating cattle (still producing milk) and dry cattle (usually in the latest part of pregnancy, which has ended its lactation and being prepared for the next lactation; others refer to heifer (young female bovine from the first heat to the time she gives a first calf), calf (young male or female cow before first heat) and bull (male cow after the first heat)

from the losses incurred from the reduced cattle population, but also the loss of profit from selling milk. Out of the three cooperatives, the members of Sarono Makmur Cooperative were worst affected by the Merapi eruption compared to members from the other cooperatives who lived in farther and safer locations. Both hot ash clouds and lava flow caused death and severe burns on livestock, and destruction of houses, forage sources and all equipment. Livestock mortality was caused not only by direct contact with flowing lava, but also by ash contaminated feed. Inhaling volcanic ash also caused respiratory system disorders leading to livestock death. The death of dairy cattle caused loss of milk and consequently decreased the average milk production of farmer cooperatives in the region. Multiple burns on livestock including the udder made them sick thereby reducing livestock productivity. The burns on cows together with the ensuing shortage of feed caused infections and decreased body weight of livestock.

Destruction of farm assets did not exterminate their desire to build back their farming life. With low levels of education, skills and capital, rural farmers have difficulties in switching to other economic activities as a source of livelihood. Since livestock keeping is the main source of household income, government aid is needed in order to rebuild farms, revive business activities and recover from the mental shock these households went through during the disaster. Apart from financial and physical losses, the Mt. Merapi disaster brought in its wake psychological trauma on its victims (Elder and Conger 2000; Sutherland and Glendinning 2008; Lorenz et al. 2000). Immediate actions would have a greater impact on the revitalization and survival of affected farmers. Proper mechanisms and strategies for farm rehabilitation and reconstruction by government are required. Government recovery programs covered livestock housing, dairy breed replacement, and feed aid through the group. The recovery program required farmers' groups join an umbrella organization, known as GAPOKTAN (Gabungan Kelompok Tani), to facilitate the administration, coordination and monitoring of financial assistance and any other forms of support. The coordination and relationship among groups in recovery

period were important due to the fact that many farmers/groups were involved in activities of famer cooperatives. Forming larger group enabled individual farmers/groups collaborate with each other institutions/agencies in solving problems in their farming activities.

9.4 Role of GAPOKTAN in Dairy Farming

Farmers' groups which do not belong to any organization have low prestige, and have more difficulties in getting through the bureaucratic systems and realizing their objectives. Farmers' groups need to be affiliated to larger organizations. The success of a group depends on its capacity to bridge with other groups or link its members with the world outside the hamlet, and to bring new information about techniques, products, and markets to the hamlet. The group needs permissions for doing certain activities and technical support from agricultural services and research stations. Also, the services of banks and other suppliers of credit are needed, as well as better telecommunications, water supply and transport systems. The more the management board succeeds in linking the group with the outside world for support, the more enthusiastic the members become. Farmers' groups development aimed at improving the ability of each farmer group in carrying out its functions, increase the capacity of agribusiness to grow, and strengthen farmers' organizations to become strong and independent groups.

In Indonesia, farmers' groups were made to join a larger collective organization called GAPOKTAN. Farmers' groups which belong to GAPOKTAN are more efficient and effective in the provision of agricultural inputs, capital, improvement or expansion of farming along the value chain including production, distribution and marketing, and cooperation in improving bargaining position. GAPOKTAN have given a new meaning, including new forms and roles. First, GAPOKTAN is directed as an economic institution for dairy farmers besides farmers' groups and cooperatives. This intergroup organization has a common interest in the development of dairy farming to raise productivity and income. Second, GAPOKTAN is a social institution as it promotes not only bonding through a sense of belongingness and solidarity within groups but also partnership with various stakeholders in achieving optimal farming outcomes.

GAPOKTAN can be formed by farmers' groups within an administrative area to promote their common interest. This organization performs various functions including supplying equipment and feed, providing venture capital and distributing credit/loans to farmers, processing farm produce/products (milling, grading or packing) to enhance value addition, and promoting trade and marketing of agricultural products (Syahyuti 2007). By 2006, at least 3,000 GAPOKTAN units have been formed. In 2007, the target formation of GAPOKTANs was 22,000 units, with a further target to register 66,000 GAPOKTANs by 2009. This means that each Indonesian village would have a GAPOKTAN. Different from other agricultural institutions in Indonesia, GAPOKTAN is organized by the farmers for the farmers in order to promote farming in their respective localities.

In the wake of the Mt. Merapi disaster in 2010, dairy farmers' groups in Sleman regency, particularly around Merapi Valley, came together to form a GAPOKTAN called Merapi Mandiri (farmer around Merapi valley can survive by their own resources) in order to obtain help and support from government and other development agencies to rebuild their farms. Farming has historically been the custom of people living around Mt. Merapi, who cultivate rice, corn, cassava and a wide variety of fruits and vegetables. Merapi Mandiri is quite different from other types of GAPOKTANs. This is the only GAPOKTAN which involves smallholder dairy farmers' groups, while the members of other types of GAPOKTAN are beef cattle or plantation farmers. It consists of three small dairy farmers' groups. They are Sidodadi (Weron village), Sedyo Mulyo (Boyong Village) and Ngudi Makmur (Kaliadem Village). Each group has a representation in the three existing cooperatives. Sidodadi, Sedyo Mulyo and Ngudi Makmur groups joined UPP Kaliurang Dairy, Warga Mulya and Sarono Makmur cooperatives, respectively.

The local government agency, Bank Nusantara Parahyangan (BNPB), was responsible for disbursing funds, through local administration offices and the GAPOKTAN, to farmers. Overall, Merapi Mandiri GAPOKTAN was established in order to manage and distribute government aid for the livestock production infrastructure repair. The disbursed funds are used for livestock procurement and the provision of working capital for purchasing feed and animal health services. The funds were expected to be used to purchase about 4,000 dairy cattle to replace their livestock. In addition, the agricultural ministry proposed a supply of additional cattle through a social aid program to revitalize dairy farmer's economy and milk production in areas located nearer to center of the volcanic eruption. The GAPOKTAN received and distributed social assistance funds by wire transfer to each group's bank account. Funding from government is sent to GAPOKTAN's bank account for onward disbursement for group activities and procurement schedule. The process of procurement goods was done transparently, witnessed by community leaders or local village officials.

9.5 Characteristics of the GAPOKTAN Members in Mt. Merapi Area

Three dairy farmers' groups (Sedyo Mulyo, Ngudi Makmur and Sidodadi groups) in Sleman regency were affected by Mt. Merapi eruption, and they are all members of Merapi Mandiri GAPOKTAN. In terms of recovery from Merapi disaster, the board of GAPOKTAN is much involved. The board has representatives from each farmer group. GAPOKTANs assist in distributing government aid to groups. Many farmers had their individual cages for housing cattle destroyed during the disaster. With colony cages, smallholders households keep their cows together in a large dairy shed but individual farmers were still responsible for feeding and maintaining their cattle. Communal forage production, large-scale feed (silage, concentrate) production, access to milking machine and rearing of young livestock are other

Table 9.3 Characteristics of dairy farmers' groups after Mt. Merapi eruption

	Dairy farmers' groups		
Characteristics	Sedyo Mulyo	Ngudi Makmur	Sidodadi
Established (year)	1992	1996	1985
Dairy farmers (people)	77	32	54
Number of dairy cattle	312	90	226
Membership fee (IDR)	5,000	1,000	2,000
Model of dairy cow housing	Individual cages	Colony cages	Individual and colony cages
Feed supply	Concentrate from dairy cooperative and farmers Roughages: farmers themselves	Concentrate from dairy cooperative Roughages: farmers themselves	Concentrate from dairy cooperative Roughages: farmers themselves
Concentrate utilization (t/month)	18 (from dairy cooperative) and 3 t (nondairy cooperative)	20 (from dairy cooperative)	8 (from dairy cooperative)
Health services	Animal health division of the agriculture department	Animal health division of the agriculture department	Animal health division of the agriculture department
Milk production (l/day)	1,000	1,100	500
Milk composition	Specific gravity Morning milk: 1.023 Afternoon milk: 1.022–1.023 Milk fat : 3.5–3.6 % SNF : 7.6–7.7 %	Fat : 3 %, TS: 11.5 %	Specific gravity Morning milk: 1.024 Afternoon milk: 1.020

Source: Field Survey, 2012
Note: SNF denotes solid- non-fat, TS denotes total solid

benefits of the group membership. The characteristics of these three groups are described in Table 9.3. All these groups under Merapi Mandiri GAPOKTAN were established in 1985, 1992 and 1996 for Sidodadi, Sedyo Mulyo and Ngudi Makmur groups, respectively. Membership of these groups ranges from 32 for Ngudi Makmur to 77 for Sedyo Mulyo. Although the smallest group, Ngudi Makmur has the highest milk production followed by Sedyo Mulyo and Sidodadi in that order.

Dairy farmers' groups in Indonesia tend to have similar functions and management. Sedyo Mulyo group joined Warga Mulya cooperative for milk marketing and supply of farm inputs. Farmers have to join a group because dairy cooperative only accept milk from group's deposit. The groups usually collect milk from their member's cattle and sell to cooperatives. This group can determine the selling price of products to consumers directly, but it does not have a role in milk price determination to cooperatives. Dairy farmers can only propose the selling price of milk but final decision lies with the farmers' cooperatives. Sedyo Mulyo group sells milk to

Warga Mulya Cooperative which, in turn, sells the milk to Sari Husada, the biggest milk processing company in the province, with its own standard and complex criteria in receiving milk from farmers/groups. The milk can be used to produce sweet condensed milk, milk powder, ultra heat temperate milk and other milk products. Selling price of milk to the cooperative is IDR 3,000 and the selling price to consumers outside is IDR 4,000. The quantity of milk sold to the cooperative can reach 1,000 l/day while sale of milk to other consumers is about 200 l/month. The cooperative can deposit as much as 3,500 l of milk with the milk processing company every 2 days. Direct sales to consumers amount to 600 l/day at a price range of IDR 4,250 to IDR 4,750 per liter. The group also benefit from sale of cattle feed and milk sales outside the cooperative.

This group also has an experience in implementing Artificial Insemination (AI). The dairy cattle in this group reached the best service per conception (S/C) 1. The level of S/C was good because of a successful implementation of artificial insemination in dairy cattle. Low S/C can be improved by early weaning of calves (immediately after colostrum period) but still continue to milk feed with bucket or nipple so that the cow return to estrus soon after calving. In this group, farmers do not like to practice early weaning of calves because it needs much labor. Most farmers prefer to wean calves after 3 months. The daily milk production of Sedyo Mulyo farmers is about 1,000 l/day. This amount fluctuates depending on the quality of feed and dry phases of dairy cattle. The highest production ever achieved is 1,200 l/day and a low of 800 l/day. Milk quality is graded as 'fair" with specific gravity of 1.023–1.026, fat content and Solid-Non-Fat (SNF) of 3.5 % and 7.6 %, respectively. Physical characteristics of milk such as color and aroma should meet SNF standard. Checking milk quality is conducted prior to morning and evening milk deposit every day. Farmers may debase milk by adding some sugar, water, urea, peroxide or vegetable oil. However, the group leaders usually urge farmers not to introduce additives in milk in order to maintain milk quality.

Important costs of dairying are feed cost, labor (family labor) and veterinary cost (including insemination cost). Members of Sedyo Mulyo group use forage and concentrate to feed their cattle in individual cages. Some farmers prepare forage from their own plantation or by purchasing. They sometimes add wheat pollard and waste of tofu in the concentrate. On average, utilization of concentrate is 21 t/month (18 t was purchased from the dairy cooperative and 3 t from others). Farmers commonly buy concentrate from the group, but many of them can procure better quality ones from outside the group. Sedyo Mulyo Group can purchase concentrate from cooperatives and sell it to farmers. Concentrate price from the cooperative is IDR 120,000 but the group sells it to farmers at IDR 122,000 (extra IDR 2,000 is for group's saving). The group also take IDR 25 per liter of milk sold as group's operational cost. Each member of the group generally deposits milk with the group but they are also entitled to sell to other customers. The sale may be made using appropriate marketing channels but farmers' groups remain committed to the cooperative. Each group member has an obligation to pay compulsory savings of IDR 5,000.00 per month. Savings can then be taken back if the farmer still remains a member for about a year.

Ngudi Makmur group joined Sarono Makmur Cooperative for milk marketing and input supply. Ngudi Makmur group received aid from local BNPB in the form of dairy cattle. This aid helped farmers to rebuild their farms and improve their income after losing almost all their wealth (houses and cattle) during the disaster. Up till now, the group does not have any relationship with any other company in selling milk apart from the cooperative. The cooperative pays for the labor cost of milking cows in Ngudi Makmur group, but farmers also have to pay IDR 15,000.00 per cow milked per month. Artificial insemination is also done by the power of the cooperative at a cost of IDR 40,000 per insemination. The insemination fee applicable as of March 1, 2012 is IDR 35,000. As member of cooperative, farmers and the group get easy milk marketing and supply of inputs such as concentrate and farming utensils. According to information from the group on the survey day, average concentrate need per month of Ngudi Makmur group is 20 t at a price of IDR 3,000/kg. Payment for concentrate to cooperative is deducted from total price of milk deposit. The highest price ever achieved in this is IDR 3,200 per liter, while the lowest price ever received is IDR 3,040 per liter. Quality and the price received by Ngudi Makmur group are quite good. This is expected to increase farmer's motivation to improve milk quality in order to obtain high price. The group can sell milk to other customers at a price ranging from IDR 4,500 to IDR 5,000 per liter, but it is only in limited quantities (100 l/month) due to the agreement they have with the cooperative. Payment for milk is made by the cooperative to the dairy group on the tenth of every month, and farmers are expected to receive from the group on the 15th of every month. The cooperative pays half price for milk if it is in bad condition such as high bacteria content.

Another member of the Merapi Mandiri GAPOKTAN is Sidodadi group. This group joined UPP Kaliurang Cooperative. Sidodadi group organizes regular meeting once a month. The meeting agenda consists of social gathering, knowledge sharing and discussion of selling milk problems in the group. These activities bind members of this group together and increase their willingness to attend regular group meetings. Within the group, members have to pay contributions of IDR 2,000, consisting of IDR 1,000 for group treasury and the remaining IDR 1,000 is saved and later distributed back to members during Eid al-Fitr (end of Ramadan celebration). As member of UPP Kaliurang Cooperative, they have to pay IDR 7,000 per month as membership fee. Sidodadi group sell milk to UPP Kaliurang Cooperative. Cows are kept in the colony cages because they are not able to rebuild their own houses. Colony cages in the Sidodadi group were built from local government aid. Total dairy cow in the colony cages are 54. In the colony cages, each farmer is expected to keep an average of 2 cows with additional responsibility of feeding and cleaning. Milking is conducted by a staff from the dairy cooperative using milking machines. Total milk production from Sidodadi group is relatively low. Before Merapi eruption, this group supplied almost 40 % of total milk requirement of the cooperative of about 3,700 l/day but after the eruption, total milk supply decreased to less than 30 % of cooperative's need. Group has to also pass milk quality standard. The cooperative accepts milk with specific gravity of between 1.020 and

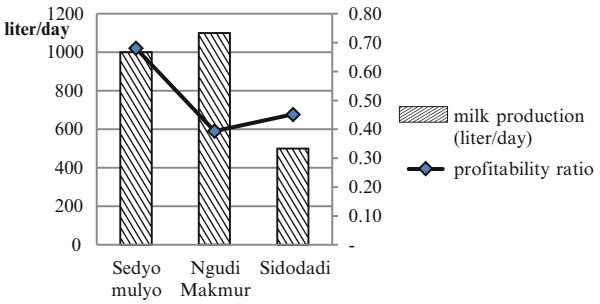


Fig. 9.2 Profitability ratio and milk production of three dairy farmers groups (2012). *Note*: Profitability ratio = gross profit/Sales of milk

1.024, with minimum total solid of 11.5 % and milk fat of 3 %. The group needs around 8 t concentrate/day. Total number of dairy cows in the Sidodadi group was 176 before Merapi eruption. Farmers who keep more than one cattle tend to vary the age of their livestock. This is to ensure that at least they have dry cows to rely on when lactating cows come to the end of milk production. Each member has to provide feed (concentrate and forage) by themselves and they are mostly purchased from the Cooperative. The cooperative has full control over milk pricing decisions. Selling price of milk from Sidodadi group before joining GAPOKTAN was IDR 2,800 and, after joining they sell at a price of IDR 2,900. Every member of this group can provide feed by themselves. They can also buy from the cooperative directly. Quite different with the other two groups, members of Sidodadi group have to pay cash when they are buying feed from the cooperative. Consequently, if farmers don't have money, they can borrow from bank. Insemination cost in this group is IDR 35,000 per insemination. Milk price reached IDR 2,900 per liter and would be paid by the cooperative every month or every 45 days. Farmers sell their milk only to cooperative. They do not have other marketing channel besides cooperative. The group has experienced an unusually high milk price of IDR 4,000 per liter, but this is very rare occurrence. Small portion of milk production is also given to calf when its mother dies. Marketing of dairy cattle in the group has been limited only to the dairy cooperative marketing. Milk marketing can be carried out extensively by the groups, but they have economic, social and cultural bond to the dairy cooperative (Ilham and Priyanti 2011).

Analysis of the financial position of each group (Fig. 9.2) shows that Ngudi Makmur has lowest profitability ratio but it has highest milk production. This is explained by the high operational cost resulting from purchase of feed. They have to buy forage because the eruption destroyed forage plants. In some cases, they needed to buy high quality concentrate at high prices. The group also has many young unproductive cows. Sometimes, whole milk is sold to the cooperative at low prices. As a result, average profitability ratio of Ngudi Makmur group is only 0.39 which is relatively lower than other groups. Sedyo Mulyo and Sidodadi groups have profitability ratios of 0.68 and 0.45, respectively. A high profitability ratio indicates that the dairy farming can make a reasonable profit, as long as it keeps the production overheads in control.

9.6 Conclusion

Majority of dairy farming is small-scale farming. Small farmers face challenges of limited farmer education, low dairy cow productivity and profitability, and low milk quality. About 85–90 % of total dairy cows in DIY Province are in Mt. Merapi valley area. Mt. Merapi eruption in 2010 damaged dairy farms in this area, mostly caused by hot ash clouds. Death of cows resulted in reduced levels of milk production in the region. Multiple burns on surfaces of cows including the udder reduced livestock productivity. As farming is, traditionally, the main livelihood and source of household income for villagers living around Mt. Merapi, proper mechanisms and strategies for farm rehabilitation and reconstruction were needed. Immediate actions would have a greater impact on the revitalization and survival of affected farming households.

Dairy farmers' groups in this area needed to rehabilitate their dairy farms. Before the disaster, Dairy farmers' groups had relationship with only cooperatives. After Mt. Merapi eruption in 2010 the dairy farmers' groups join Merapi Mandiri GAPOKTAN, which has the leverage to facilitate government assistance to farmers. GAPOKTANs were established to solve problems of smallholder farmers in farm management. Smallholder farmers face a myriad of constraints including lack of access to government services, financial problems, difficult on milk marketing, unavailability of farming inputs, and lack of access to knowledge and technology. GAPOKTANs, acting in partnership with other development agencies, played an important role in improving smallholder dairy farming management in a sustainable way. Through GAPOKTANs, government assistance was channeled to members of farmers' groups which are affiliated to GAPOKTAN. They also create linkages with other institution to support and to drive activities of farmers' groups in terms of improving value of milk production. Government offices, research institutes, universities, state and private corporations, NGOs and farming groups should work together to formulate the best scenario for farming rehabilitation. This is a clear example of how social capital embodied in groups can be used to promote socioeconomic development.

References

Andarwati S, Haryadi FT (2010) The effect of dairy cattle ownership and farmers demography factors on the evacuation moving farmers behavior at Merapi volcano area (case study at Kaliadem, Sub Village, Yogyakarta, Indonesia). In: Proceeding on the 5th ISTAP, Faculty of Animal Science, Universitas Gadjah Mada, Yogyakarta, 19–22 Oct 2010

DGLS (Directorate General of Livestock Services) (2012) Livestock statistical book. Directorate General of Livestock Services, Jakarta

DIY Provincial Livestock Office (2012) Livestock statistical report. Ministry of Agriculture Daerah Istimewa Yogyakarta Province, Indonesia

Elder GH Jr., Conger RD (2000) Children of the land. Adversity and success in rural America. London: The University of Chicago Press

Erwidodo (1998) Dampak krisis moneter dan reformasi ekonomi terhadap industri persusuan di Indonesia (effect of monetary crisis and economic reformation on dairy industry in Indonesia). Proceeding of National Seminar of Agricultural Department, Indonesian Center for Agriculture Socio Economic and Policy Studies, Bogor

Hewitt (1983) Interpretations of calamity from the viewpoint of human ecology. In: Kenneth (ed). Winchester: Allen & Unwin

Ilham N, Priyanti A (2011) Dampak bencana merapi terhadap usaha sapi perah di Kabupaten Sleman (Merapi eruption impact to dairy farming in Sleman Distric). WARTAZOA 21(4)

Lorenz FO, Elder GH Jr, Bao WN, Wickrama KAS, Conger RD (2000) After farming: emotional health trajectories of farm, non-farm and displaced couples. Rural Sociol 65(1):50–71

Sutherland LA, Glendinning T (2008) Farm family coping with stress: the impact of the 1998 ice storm. J Comp Fam Stud 39(4):527–543

Swastika DKS, Ilham N, Purwantini B, Sodikin I (2005) Dampak krisis ekonomi terhadap prospek pengembangan peternakan sapi perah (impact of economic crisis on development of dairy farming). Research report. Indonesian Center for Agriculture Socio Economic and Policy Studies, Bogor

Syahyuti (2007) Kebijakan pengembangan gabungan kelompok tani (GAPOKTAN) sebagai kelembagaan ekonomi di pedesaan (the policy of GAPOKTAN development as financial agent in rural areas). Pusat Penelitian Sosial Ekonomi, Bogor

Taiban S (2013) From rekai to labelabe: disaster and relocation on the example of Kucapungane, Taiwan. Anthropol Noteb 19(1):59–76

Chapter 10
Capacity of Rural Institutions in Implementing Decentralized Development in Indonesia: Case of Three Villages in Purbalingga District, Central Java Province

Sutiyo and Keshav Lall Maharjan

Abstract Through decentralization policy in 2001, the central government of Indonesia has transferred tasks to plan, execute and evaluate rural development to village government. Nevertheless, to be successful, sufficient local capacity is needed. This study aims to measure capacity of rural institutions, realization of capacity to address livelihood problems and capacity development delivered by the government. It focuses on village officers, neighborhood group, village parliament and village development committee. Through cases study in Serang, Kedarpan and Sumilir villages, it was found that majority of capacity indicators were perceived to be good enough. However, capacity realization was hampered by the problem of weak coordination. Village head, culturally the highest patron in village, was still too dominant and delimitating the other institutions to perform their tasks. Such condition was exacerbated because district government put emphasis on capacity development of village officers at the expense of neighborhood group, village parliament and village development committee. This study recommends that to make more balanced power relation among rural institutions, the government should develop individual capacity of village parliament, village development committee and neighborhood group.

Keywords Decentralization • Local capacity • Local institution • Rural development

Sutiyo (✉) • K.L. Maharjan
District Government of Purbalingga, Central Java Province, Indonesia
Purbalingga District, Indonesia
e-mail: sutiyobanyumasan@yahoo.com

K.L. Maharjan (ed.), *Communities and Livelihood Strategies in Developing Countries*,
DOI 10.1007/978-4-431-54774-7_10, © Springer Japan 2014

10.1 Introduction

With its vast area, scattered population and diverse culture, there is strong rationale for Indonesia to adopt decentralization. However, the New Order regime of Suharto (1968–1998) perceived decentralization more as a threat to state unity and governed Indonesia as a strong centralized state. Top–down planning was adopted by the regime. Regardless of the diverse nature of rural areas, development programs were centrally created through "one design fits all" approach (Antlöv 2000, 2003). Although many programs were delivered to rural areas, local initiative was limited because the decision was made by the district government, either directly or indirectly through the obligation to seek approval (Antlöv 2000, 2003; Evers 2000; Ranis and Stewart 1994; Tinker and Walker 1973).

In 1998, however, the regime collapsed and reform movements demanded decentralization. As a result, the government subsequently established Law 22/1999 on Regional Governance and its counterpart, Law 25/1999 on Fiscal Balance,[1] through which Indonesia rapidly moved to one of the most decentralized countries in the world (World Bank 2007). With implementation starting in 2001, decentralized system granted village governments the discretion to plan, execute and evaluate development projects based on local initiatives. Simply speaking, Antlöv (2003) states that the legislations are favorable to local democracy because the upper government levels cannot interfere in village decision making as long as it has not violated the law.

Nevertheless, there is no guarantee that decentralized system will create the better livelihood outcomes to rural people. Studies in many countries find that the success of decentralization in improving local livelihood heavily depends on capacity of local institutions (Aref et al. 2009; Blair 2000; Johnson 2001; Jutting et al. 2005; Uphoff et al. 1998). In Indonesia, low capacity of village governments has been of great concern. Studies conducted in the initial years of decentralization find that many rural institutions faced difficulties in adapting to the new system in terms of understanding the roles they should play (Alatas et al. 2001; Antlöv 2003; Bebbington et al. 2006; Dharmawan 2002; Widianingsih 2005).

After about 10 years of decentralized system in Indonesia, a good understanding of local capacity will help the government to formulate a policy on capacity development of rural institutions. This study has three main objectives, which are to measure the capacity of rural institutions to execute decentralized policies, to analyze the realization of capacity to address local livelihood problems and to evaluate the capacity development done by the government.

[1] In 2004, the laws were revised into Law 32/2004 on Regional Governance and Law 33/2004 on Fiscal Balance.

10.2 Literature Review

10.2.1 Concept of Local Capacity

UNDP (2002, p. 8) defines capacity as "the ability to perform functions, solve problems, and set and achieve objectives". Uphoff (1986) argues that the concept of capacity operates not only at individual level, but also at organizational, community, regional and national levels. He suggests that a study aiming to analyze local capacity should narrow its scope to an area where the residents have a long-standing interaction and emergent collective identity.

One way to understand individual capacity is by using an asset-based conceptualization of capacity made by Bebbington (1999). His main idea is that assets, which according to Scoones (1998) consist of natural, human, economic or financial and social capital, are not the only resources an individual has, but also their source of capacities. Bebbington's main idea is that the possession of assets will enable people to act. Thus, people's capacity can be measured from their access to different types of assets and the ways in which they transform assets to meet their preferred objectives. Although Bebbington's concept is originally created to analyze the capacity of rural people in addressing livelihood problems, his conceptualization is still applicable in analyzing the role of local capacity in implementing decentralization.

Although individual capacity is the main source of organizational capacity, most literatures agree that the later is not just the sum of the former (Bebbington 1999; Goodman et al. 1998; JICA 2004; Mizrahi 2004). JICA (2004) suggests that in addition to individual capacity, organizational capacity is also determined by leadership, organization structure, resources and management strategy. Further, capacity at the community level is more complex than organizational and institutional capacity. Uphoff (2004) notes that a community is often not a cohesive and a harmonious social entity, but divided by various religious and clan separations that may result in a considerable level of local conflict. Therefore, study on community capacity needs to discuss the relationship among various organizations within the community.

Capacity is task specific. Mizrahi (2004) suggests that, in an analytical framework, indicators of capacity should be created based on "capacity of whom" and "capacity to do what". Different institutions need different set of capacity indicators. For example, indicators of capacity for village officers are different from those of village parliament as well as village development committee. Similarly, indicators of capacity to implement rural development tasks are different from the indicator of capacity to implement other tasks.

10.2.2 Concept of Community Leadership

Several studies indicate that community leaders play substantial role in the implementation of decentralization. Even in many societies, particularly rural areas,

villagers often think that it is the responsibility of their leaders to bring development programs. Further, if the programs cannot be successful, lack of community leadership is blamed for it (Ricketts 2005). Goodman et al. (1998) state that without community leadership, local capacity development may only create disorganization.

Uphoff et al. (1998) argue that successful implementation of rural development programs depends, to large extent, on the leadership. Study by Takeshi (2006) in Bandung district of Indonesia shows that local leaders could improve the inclusiveness of development planning, somehow making the budget more tailored to satisfying the needs of the people. In contrast to Takeshi (2006) study, Hadiz (2004), through his study in North Sumatra regions of Indonesia, finds that local leaders themselves captured the decentralized resources for their own interest, and created a clan segregation that might lead to local conflict. From those two studies, it can be understood that community leaders can either facilitate or obstruct the success of decentralization.

Despite the efforts to understand the linkage between community leadership and local capacity, little is known about the type of capacity that a community leader should have. Because community leadership is a very location specific, different culture and location needs different leadership style. Therefore, the capacity needed by a person to become an effective leader in one location may be different from other locations.

Study by Mulder (1996) on concept of Javanese leadership provides very useful references to understand the expectation of villagers about their leaders. According to Mulder (1996), villagers in Java see their leader as the father of community, and as such they expect guidance, fair treatment and protection. Ki Hadjar Dewantara, a prominent leader of *Taman Siswa* institution and nationalist movement in the nineteenth century, extracts the roles of Javanese community leader into three popular traditional principles: (1) to provide example in the front (*ing ngarsa sung tuladha*); (2) to inspire from the middle (*ing madya mangun karsa*); (3) to encourage from the back (*tut wuri handayani*). 'To provide example in the front' means becoming the paragon of the community in terms of providing clear information and guidance and walking the talk. 'To inspire from the middle' means creating a new idea for the betterment of the people. 'To encourage from the back' means supporting and motivating the community (Mulder 1996; Velsink 1996).

10.2.3 Local Capacity, Community Leadership and Livelihood Problems

There is a notion that rural institutions originally have the capacity to solve local problems. In one sense, this notion is very reasonable. Compared to the outsiders, rural institutions are more accustomed with local conditions. Thus, they understand the local intricacies and possible ways to deal with their difficulties better. It is suggested that central government, donors and consultants not to meddle with the workings of the rural institutions. They should be empowered through the provision

of financial and technical assistance thereby enabling them to bring enhanced service delivery to the community (Cohen and Peterson 1997; Parker 1995; Rondinelli and Cheema 2007).

Various development programs have been implemented in many countries with emphasis on the role of local institutions. The program of rural community forest in Nepal is an example of success story of institutional approach to local resource management. Chetri et al. (2007) and Joshi and Maharjan (2007) find that local institution in rural Nepal can successfully manage forest resources in order to meet the twin objectives of forest conservation and rural poverty alleviation. Another example is a study by Blair (2000) in Bolivia, Honduras, India, Mali, Philippines and Ukraine, which finds that empowerment of local government body leads to the increase in government responsiveness.

Despite the success story of institutional approach, decentralizing development tasks to rural institutions will not be a simple work. Johnson (2001) finds that in many countries applying top down development strategy for a long time, local capacity has been eroded. Similarly, UNDP (2002) concludes that, despite training of thousands of people, lack of skills and weak institutions are still the major problem of rural development. In addition, Bebbington (1999) argues that good capacity does not always create good performance. The performance of an institution will depend on capacity of other actors, social structure determining pattern of relationship among actors, and complexity of the problems that they want to solve. Therefore, one should avoid justifying the capacity by only looking at the performance, and vice versa, should not assume that good capacity will always result in good performance. The success of rural development depends not only on the capacity of each rural institution as a separate entity, but also on their ability to work together in a synergetic way.

In the context of Java, rural community is traditionally built based on principle of solidarity, but not equality (Mulder 1996). The power relation is hierarchical, putting village head as the father of community (Irawanto 2011; Mulder 1996; Velsink 1996). The leadership is autocratic with very limited room for the followers to complain. Showing respect and obedient to the leader, minimizing overt expression of disagreement and avoiding open conflict are commonly practiced to maintain village harmony (Irawanto 2011).

10.3 Rural Institutions Covered in this Study

Indonesian village is not only a community, but it is also a government at the lowest tiers of administration. Because decentralization is a matter of task distribution among government levels, the nature of village as government level is more prominent in the regulations rather than the community group. Thus, this study will focus only in the governmental institutions, which is the institutions whose powers are given by the government (Uphoff 1985).

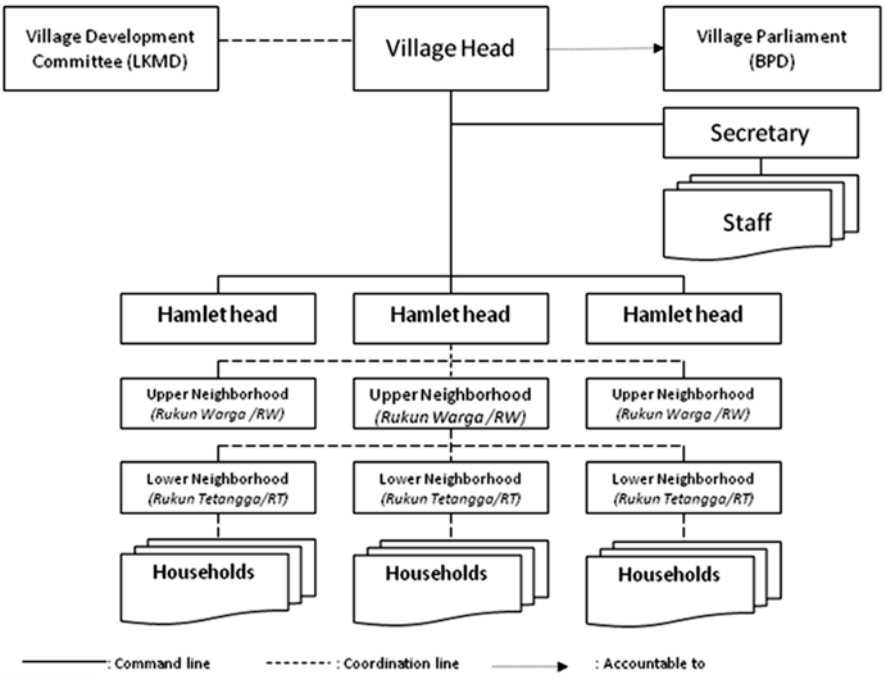


Fig. 10.1 Structure of village government

During the New Order regime, to increase the efficiency of top–down planning, the regime homogenized village government structure (Antlöv 2000; Smoke and Lewis 1996; Tinker and Walker 1973). Various institutions were established in rural areas. Not only did they exist throughout all the villages with the same structure, but also they were the only organizations through which communities channelled their concerns to government (Antlöv 2000, 2003; Evers 2000). Above all institutions, village head was the highest leadership of village government. His power was unquestionable because he had both executive and legislative power. There was no parliament body in the village, and no obligation for village head to be accountable to community.

After decentralization policy, the government introduced village parliament to supervise village head. This might be the biggest structural change brought by decentralization policy in rural institution setting. Currently, in general, Regulation of Ministry of Home Affairs (MoHA) 5/2007 on Rural Community Institution is distributing the tasks of rural development to three governmental institutions, namely, village officer, village parliament and village development committee (Fig. 10.1). There are also four levels of rural leadership consisting of village head, hamlet head, upper neighbourhood head and lower neighbourhood head. They are the institutions practically involved in almost all rural development projects.

The following sub sections will briefly describe the origin, membership, function and capacity indicators attributed to each institution. Following Mizrahi (2004) suggestion, indicators of capacity are made based on "capacity of whom" and "capacity to do what". Thus, capacity indicators are set based on the tasks of each institution.

10.3.1 Village Officer

Village officer consists of about ten people including village head, secretary, staff and hamlet heads. People directly elect village head every 6 years. Village secretary, staff and hamlet heads are recruited from villagers. Their term of service is up to 56 years old. While village secretary and staff conduct village administration, hamlet heads are community leaders in their respective areas. Among all institutions covered in this study, only village officers routinely work in village office to earn salary from their position. Their salary comes from two main sources: *bengkok* land, which is a specific plot of land given to each village officer during his time of service; and some supplementary allowance given by district government.

The task of village officers is to administer rural development. Therefore, the indicators used to assess their capacity are their understanding on rural development mechanism, skill on proposal writing, skill on budget reporting and computer literacy. Further, village heads and hamlet heads are the leaders of their respective communities. At the planning stage, they are responsible for disseminating information, formulating strategy, resolving problems and accommodating different inputs from community. At the execution stage, they are responsible for encouraging community to participate. At the evaluation stage, they are responsible for providing report on transparency and accountability. By considering these tasks and the concept of Javanese leadership identified by Mulder (1996) and Velsink (1996), their leadership capacity indicators are set as follows:

1. Informativeness: provide information and socialize the development programs.
2. Creativity: able to identify the most effective ways to tackle local problems and create new programs for the betterment of the local livelihood.
3. Fairness: distribute development programs fairly without discriminating against any individual or group.
4. Encouragement: motivate people to participate in development.
5. Responsiveness: give prompt response to local problems.
6. Accountability: provide the report of village budget.
7. Submission to consensus: obey the decisions made at meeting.

10.3.2 Neighborhood Group

Neighborhood group originally came from *tonari gumi* system introduced by Japanese army during their occupation of Indonesia. Neighborhood group consists

of two levels. The lower level is Neighbor Solidarity Unit (*Rukun Tetangga*; RT), which is group of about fifty households living in the same area. The upper level is Community Solidarity Unit (*Rukun Warga*; RW), which is association of 2–5 RTs adjoining each other. All households are automatically the member of neighborhood groups. Villagers elect their heads every 5 years, and their position is set below the hamlet heads. However, they are not part of the village officers.

Initially created to mobilize people, neighborhood groups have evolved to become community organizations having broader functions ranging from maintaining neighborhood security, conducting demographic registration, generating community contribution, disseminating information from the government and linking villagers and the village officers through communication. In this study, the role of neighborhood heads will be narrowed to those related to the implementation of rural development programs. The indicators of leadership capacity of neighborhood head are the same as those of village head and hamlet heads.

10.3.3 Village Parliament

Village parliament or *Badan Permusyawaratan Desa* (BPD) was institution introduced after the decentralization policy in 2001. It consists of 5–11 people elected every 6 years. Different from the other levels of parliament where the candidates run for election through political party, villagers run for village parliament not through political parties but directly as individuals. There is formally no work linkage between village parliament and the other levels of parliament.

Regulation stipulates that their tasks are to channel community aspirations, supervise village officers and enact village decrees. Therefore, capacity indicators of village parliament are the ability to generate aspiration and to monitor village government.

10.3.4 Village Development Committee

Village Development Committee or *Lembaga Ketahanan Masyarakat Desa* (LKMD) was introduced in 1980s. It consists of about ten people charged with responsibility of executing physical projects. The head is elected every 5 years, more often only by neighborhood heads, while the members are selected by the elected head. The pattern of relationship with village officer and village parliament is coordination, consultation and partnership.

The main tasks of Village Development Committee are to execute the physical project and to mobilize the labor, cash and other resources. Therefore, capacity indicators of village development committee are technical skill in infrastructure building and ability to mobilize resources.

10.4 Research Area and Methodology

10.4.1 Study Sites

By assuming that livelihood problems are more profound in poor localities, this study purposively selected a poor area as study site. Central Java province was selected because it was one of the provinces with the largest number of poor people. In 2010, about 5,369,160 of population in this province were poor or having income less than US$ 1.54 Purchasing Power Parity (PPP) per person per day (CSA 2010). Within the province, Purbalingga district was selected because it was relatively far from city areas, with many characteristics of a rural setting still being dominant.

Since livelihood problems are closely related to the agro-climatic conditions, one village each from the three agro-climatic zones existing in the district were selected. Serang, Kedarpan, and Sumilir Villages were selected to represent the high-dry, middle-dry and low-wet areas, respectively. Serang is located at latitude 7°25′ S and longitude 109°29′ E and about 800–1,000 m above sea level (masl). Kedarpan is located at latitude 7°38′ S and longitude 109°52′ E and about 400–500 masl. Sumilir is located at 7°46′ S and 109°35′ E and about 50–100 masl (Fig. 10.2).

10.4.2 Method of Data Collection and Analysis

Data for this study include both primary data from interviews, questionnaire and observation and secondary data from statistical reports and official documents. This

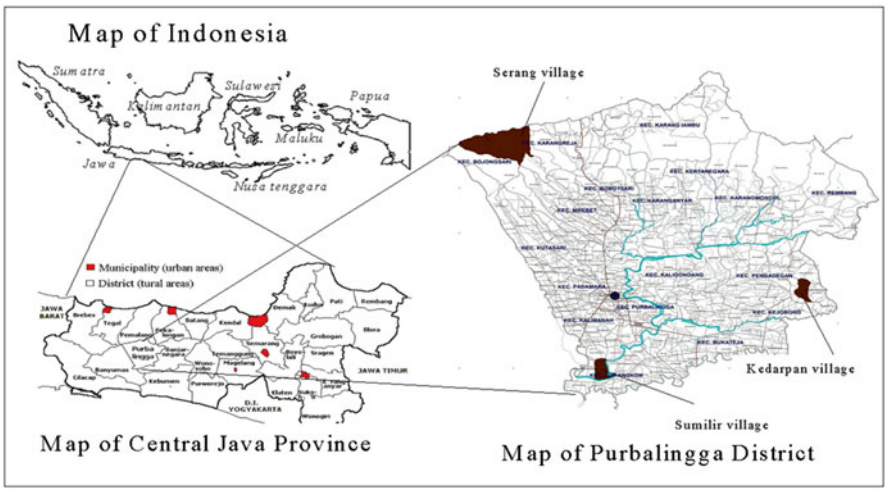


Fig. 10.2 Map of research location (not for scaling). *Source*: Central Java Local Planning Agency (2010), Purbalingga Local Planning Agency (2006), World Bank (2006)

study is based on two main periods of fieldwork, which were from February to March 2011 for initial data collection by interviews and observation and from January to February 2012 for second visitation and questionnaire administration. In-depth interviews were conducted with village heads, heads of village parliament, heads of village development committee, some heads of neighborhoods and officers from district government. This study also administered questionnaires to villagers and village officers, and each group received different types of questionnaires. Observation was conducted by visiting some development outputs and by attending several village meetings.

Official list of households in village office was classified based on hamlet, gender and relative economic status, and about 10 % of them were randomly selected. Some adjustment was made due to unavoidable reasons in the field. The final number of respondents from household heads covered 232 people, who consisted of 113 people in Serang, 61 people in Kedarpan and 58 people in Sumilir. This study also took all village officers consisting of 11 officers from Serang, 12 from Kedarpan, and 11 from Sumilir, to be the respondents.

The data are mainly analyzed through qualitative approach. In addition, some quantitative analysis is supplemented through scoring method. To measure the capacity of rural institutions, this study will analyze perception given by respondents in the questionnaires. Their perception is arranged in *Likert* scale ranging from poor (given score 1), slightly poor (given score 2), good enough (given score 3) and good (given score 4). Further, respondent's answer is tabulated, and a mean/average is created by dividing total score by total respondents. The interpretation of the mean is: Score 1–1.74: poor; Score 1.75–2.49: slightly poor; Score 2.5–3.24: good enough; Score 3.25–4: good. To minimize bias of perception, the scores will be triangulated with information gathered from interview, observation and documentary studies.

10.5 Results

10.5.1 Socio-Economic Condition of Research Areas

Serang is located at foot of Slamet Mountain, a relatively high dry land area. The village covers an area of 13 km^2, which is the largest village in Purbalingga District. By 2011, there were 1,426 households residing in the village, of which 65 % of household heads were farmers (Table 10.1). The main crops produced there were potatoes, cabbage and carrot. Supported by the relatively high price of vegetable, most farmers in Serang told that farming was their main source of income. However, many farmers in Serang noted that soil fertility had substantially been decreased over the past 10 years. They blamed inappropriate utilization of chemical fertilizers for this soil fertility decline. Their assertion on causes of declining soil fertility might be true because government policy to subsidize chemical fertilizers in 1970s

Table 10.1 Ecological and socio-economic condition of selected villages, 2011

No	Condition	Serang	Kedarpan	Sumilir
1.	Ecological and geographical			
	Size of territory (km^2)	13.09	2.25	2.26
	Ecological character	High dry land	Middle dry land	Low wet land
	Main farming commodity	Vegetable	Cassava	Paddy
2.	Socio-economy			
	Number of households	1,426	585	447
	Occupation of household heads			
	Agriculture (%)	77	46	52
	Salaried job (%)	9	24	32
	Labor (%)	1	6	1
	Business (%)	9	19	7
	Jobless (%)	4	5	8
3.	Physical infrastructures			
	Number of elementary schools	6	2	2
	Number of kindergartens	4	2	1
	Number of village polyclinics	1	1	1
	Household coverage of electricity (%)	92	97	91
	Average distance to sub-district capital (km)	5	2	4

Source: Purbalingga CSA (2011a, b, c)

made them very cheap in the market, somehow leading to their utilization above the ideal standard. After the government reduced subsidies on production inputs in 1990, planting vegetable became very expensive as farmers had to spend more to procure fertilizers and disinfectants. There were some local banks at sub-district level providing credit for the farmers, but not all farmers could access credit since the banks always asked for some form of collateral. Harvest failure also sometimes occurred due to disease attack or unanticipated weather conditions.

Kedarpan, ecologically, is located in middle dry land area. The village covers an area of 2 km^2, which was inhabited by 585 households in 2011. About 44 % of household heads were farmers with main crop being cassava. The low price of cassava made farm income not able to meet daily needs of many farmers. Most farmers told that their main income sources were beyond the agricultural sector, or even beyond the village. While the villagers could no longer rely on the agricultural sector for their livelihood, job opportunities within the village were very limited. Villagers individually tried to increase income through trading, part-time livestock, working on other people's land, becoming mason or going to urban areas as temporary migrants.

Sumilir is located in low wet land, just in the watercourse of Klawing River, which is one of the biggest rivers in Purbalingga district. The village covers an area of 2 km^2 with total number of households in 2010 being 447. About 50 % of household heads worked in farming with main crop being paddy. Irrigation covered most of cropland, and paddy could be planted twice a year. Similar to Serang, many farmers noticed a decline in soil quality over the past few years, and inappropriate

utilization of chemical fertilizers was blamed for this. The other problem associated with paddy cultivation in the area was rats-attack. During the rainy season, Klawing River flooded the cropland and brought a lot of rats and trash. Thus, rat-attacks were quite frequent, which substantially decreased paddy harvest.

All three villages had some basic physical infrastructure. State kindergartens and elementary schools were available in all three villages, and a private low secondary school was available in Serang. Each village had a polyclinic with one midwife to assist during labor at birth and provide basic medical treatment. Electricity network was also available with household coverage of above 90 %. Small clean public water facility was available only in few neighbourhoods in Serang and Kedarpan, thus most of villagers still used uncovered well as their source of drinking water. Serang and Kedarpan villages often faced difficulties in obtaining clean water during dry season. Irrigation was available only in Sumilir village. Markets, public transportation, post office and local banks were only available in the sub-district capital. The main roads in the villages were asphalted, but in most locations, they were severely damaged during the 2012 field visits.

The members of rural institutions come from better educated groups within the community. Their education level was mostly high secondary level. In term of age composition, those in Serang are, on average, younger than the other two villages (Table 10.2). Serang and Kedarpan also have younger village heads compared to Sumilir. Before becoming the village heads, both Serang and Kedarpan village heads spent most of the time as migrants, and just returning to the village few years before election in 2008. No one has previous experience in any rural institutions. On the other hand, Sumilir has the oldest village head. He is former elementary school teacher, and has been active in some rural institutions long before the election. Further, Serang village head has the highest education level compared to Kedarpan and Sumilir headman.

In terms of occupation, the three villages have many similarities. Farmer, civil servants and retired persons dominated the institutions. It is imperative to note that out of the total population, civil servant and retired persons constituted only 2 % in Serang, 3 % in Kedarpan and 9 % in Sumilir (Purbalingga CSA 2011a, b, c). Despite the fact that they were generally more educated than the common villagers, they had more time to be active in village government. This is why they hold many positions at formal rural institutions either through selection or appointment process.

10.5.2 Perception on Capacity of Rural Institutions

Village Officer

Leadership capacity: Rural leaders, especially village head, are the most influential actors within the community. Village decision making is influenced very much by the views of rural leaders. Although the structural change after the fall of New Order regime may have diluted the powers of rural leaders, the traditional hierarchical

Table 10.2 Profile of village government

No	Institution	Village		
		Serang	Kedarpan	Sumilir
1.	Village head			
	Education	Under graduate	High secondary	High secondary
	Age (year)	38	45	67
	Occupation background	Salaried job	Business	Salaried job
2.	Other village officers			
	Number (person)	12	11	12
	Average education (year)	10	10	11
	Average age (year)	45	43	42
3.	Upper neighborhood heads			
	Number (person)	8	5	3
	Average education (year)	7	6	6
	Occupation (farmer:non-farmer)	4:4	2:3	2:1
4.	Lower neighborhood heads			
	Number (person)	33	11	9
	Average education (year)	6	8	8
	Occupation (farmer:non-farmer)	25:8	7:4	5:4
5.	Village parliament			
	Number (person)	10	5	4
	Average education (year)	11	12	12
	Occupation (farmer:non-farmer)	5:5	3:2	2:2
6.	Village development committee			
	Number (person)	15	12	9
	Average education (year)	12	12	11
	Occupation (farmer:non-farmer)	8:7	3:9	1:8

Source: Field Survey 2012

relationship is still strong enough (Antlöv 2000). The results of questionnaires administered to villagers show that the capacity of village head is highest in Serang and lowest in Kedarpan (Fig. 10.3). However, the capacity of hamlet head is highest in Kedarpan.

In Serang, village head invited many villagers in the meetings and discussing his ideas with the villagers. During project implementation, the village head visited project sites to interact with workers and to encourage villagers to voluntarily contribute labor. The respondents also felt that he gave everyone comparable treatment and does not discriminate against any resident. Thus, most respondents perceived the village head as being good enough in conducting his function as a community leader.

Compared to Serang, the perception of respondents about the leadership capacity of Kedarpan village head is comparatively low. Village head of Kedarpan applied a strict representation system in the meeting. Documentary study finds that village meeting were attended only by the rural institution heads, mainly neighbourhood heads (Kedarpan Village Government 2010). Therefore, respondents in Kedarpan had limited understanding on what the village head was doing as a community leader. Most villagers only got the information from hamlet and

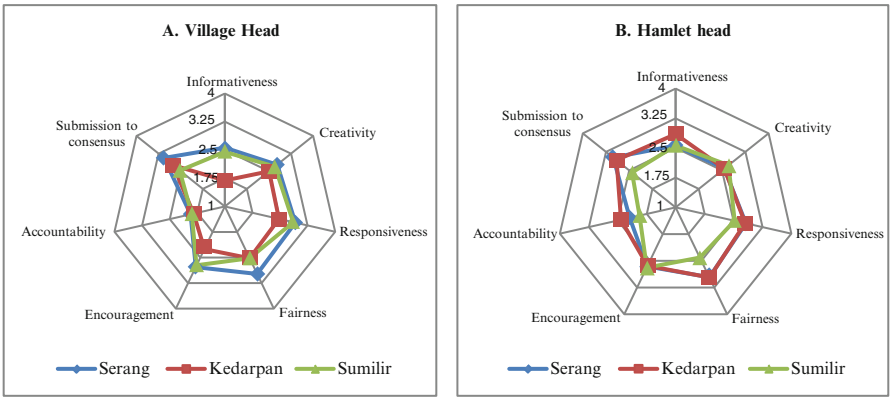
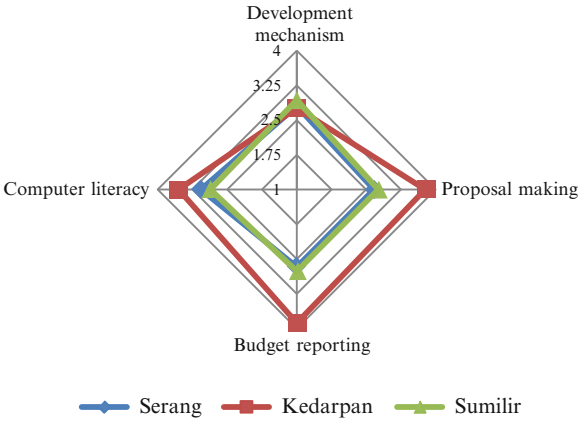


Fig. 10.3 Villager's perception on village head and hamlet head leadership. *Source*: Field survey 2012. *Note*: Score 1–1.74: poor; 1.75–2.49: slightly poor; 2.5–3.24: good enough; 3.25–4: good

Fig. 10.4 Self-assessment questionnaire on capacity of village officer. *Source*: Field survey 2012. *Note*: Score 1–1.74: poor; 1.75–2.49: slightly poor; 2.5–3.24: good enough; 3.25–4: good



neighbourhood heads. Therefore, respondents gave higher assessment to the hamlet and neighbourhood heads.

In Sumilir, the village head invited many villagers in the meetings. However, there was antipathy from some villagers due to indication of nepotism during the selection of new village officers in this village. As a result, score to indicators of fairness was quite low compared to the other villages.

In all three villages, scores of accountability are low. Observation finds that transparency was low since budget report was not put in information board. Documentary study and interview find that the meeting of responsibility after the project was finished was not always conducted (Kedarpan Village Government 2010; Serang Village Government 2010; Sumilir Village Government 2010).

Administration capacity: Self-assessment questionnaire distributed to the village officers presents that they had good enough administrative skills (Fig. 10.4). Their understanding on development mechanism, proposal making, budget reporting and

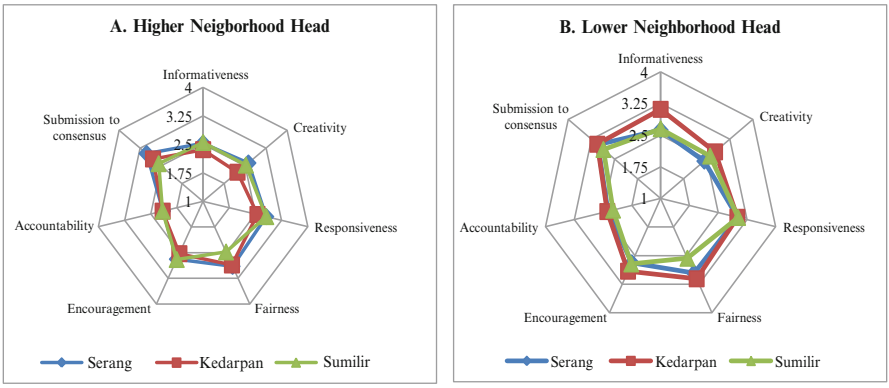


Fig. 10.5 Villager's perception on leadership of neighborhood heads. *Source*: Field survey 2012. *Note*: Score 1–1.74: poor; 1.75–2.49: slightly poor; 2.5–3.24: good enough; 3.25–4: good

computer literacy were good enough. The highest scores were in Kedarpan, which means village officers there were quite confident with their capacity. These skills were also supported by sufficient working tools. There were at least two computers and two motorcycles in each village office. In addition, the district government every year distributes various administration books.

However, these skills were not always translated into action. For example, the information board in the office that should present budget report was not up dated. Budget reports were made in a mimeo that was not accessible by villagers. Assessment of the documents finds that pages on budget plan, record of the expenses, bill proof, attendant list, technical drawing and photograph of outputs were quite well arranged, but pages of the report on local problems were just copied from year to year (Kedarpan Village Government 2010; Serang Village Government 2010; Sumilir Village Government 2010).

Neighborhood Heads

It is imperative to note that villagers were usually reluctant to become neighborhood head since they received no financial incentives from that job. Further, the roles of two levels of neighborhoods overlapped each other. In most cases, the lower levels were more active than the higher level. Thus, the scoring presents higher scores for lower neighborhood heads (Fig. 10.5).

Among the four levels of community leadership in the village, the lower neighborhood heads have the most favorable rating. This means that they became a safety net for the community when the upper community leaders failed to function. Neighborhood heads in Kedarpan have the highest scores, which may be explained by the reliance of villagers on neighborhood heads for information. As previously described, the village of Kedarpan applied a quite strict representation system whereby the villagers had limited opportunity to be invited into village meetings.

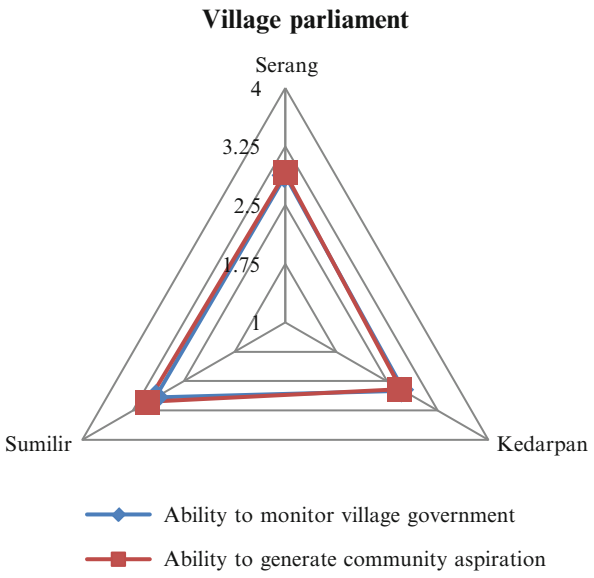


Fig. 10.6 Villager's perception on capacity of village parliament. *Source*: Field survey 2012. *Note*: Score 1–1.74: poor; 1.75–2.49: slightly poor; 2.5–3.24: good enough; 3.25–4: good

Neighborhood heads were the closest institution to the community and they were those who confronted day-to-day community problems, complaints and other affairs. Interview with the villagers finds that mostly the neighborhood heads held periodic meetings, and information on development programs were delivered through this meeting. Therefore, it is fair enough to say that although neighborhood group was initially established by the state as the tools to mobilize people, this institution had been transformed to act in villager's interest.

Village Parliament

This institution was not popular within community. Some villagers only knew the members from their hamlet while other villagers forgot at all. Factor responsible for this, may be, because regulations require no accountability on the part of village parliaments to the community. For example, there was no legal obligation to notify the decision made by village parliament to the community. Respondent's perception on capacity of village parliament is presented in Fig. 10.6.

Although the scores present good enough capacity, there was indication that they lacked the knowledge to deal with specific problems. They knew that their tasks were to give inputs and warnings to village heads. However, they did not know what to do if their inputs were neglected by village heads or when their warnings were not effective. Most of the time, they tried to reach consensus to prevent open conflict with the village head.[2]

[2] Summarized from the interview with the head of Kedarpan parliament in February 23rd, 2012, the head of Sumilir parliament in January 18th, 2012 and the head of Serang parliament in February 2nd, 2012.

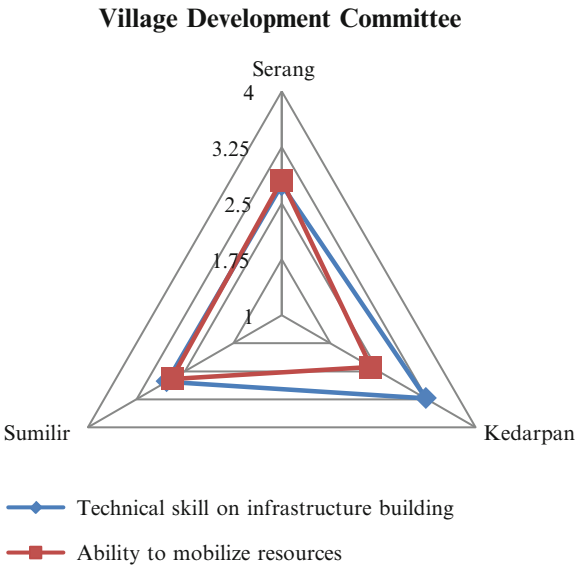


Fig. 10.7 Villager's perception on the capacity of village development committee. *Source*: Field survey 2012. *Note*: Score 1–1.74: poor; 1.75–2.49: slightly poor; 2.5–3.24: good enough; 3.25–4: good

One type of skills very important for parliament members is ability to speak in front of public during a meeting. It is found that most members from farmer were not able to speak in front of the village gathering. Simply put, they came to meetings but no new idea could be generated.[3] Members from civil servant were usually more experienced, but because they were part of the bureaucracy, they were reluctant to make open confrontation with the village policy.

Village Development Committee

Village Development Committee was quite popular. They were involved in all physical projects in terms of designing the building and coordinating the workers directly. The committee mainly consisted of persons with knowledge and experience in construction. Therefore, they had sufficient skill to carry out the small-scale infrastructure development like road maintenance, irrigation channels and small bridges (Fig 10.7).

Regulation of MoHA 5/2007 stipulates that village development committee is community organization, which partners with the village head in mobilizing local resources and executing development projects. However, the position of this institution is somewhat confusing. It is not clear enough whether the village head, village parliament or community who should control the committee. Villagers usually had limited access to the committee. Interview with the heads of village development

[3] Summarized from the interview with the head of Kedarpan village in January 12th, 2012; the head of Kedarpan parliament in February 23rd, 2012, the head of Sumilir parliament in January 18th, 2012; and the head of Serang parliament in February 2nd, 2012.

committee finds that the heads tended to be subordinate of village head rather than representing the villagers. They simply implemented the orders given by the village head, and felt answerable more to the village head rather than the community.[4]

10.5.3 Realization of the Capacity to Address Local Livelihood Problems

Two types of major problems were identified in the villages. The first was general problem, which was lack of physical infrastructure such as road, clean water facilities, irrigation, education and health infrastructure. Further, constraint of village budget was the main difficulty in developing rural infrastructure.

The second major problems were income and livelihood difficulties. These problems were related to ecological conditions of each village. Serang, a high dry land with main commodity being vegetables, faced problems of decreasing soil fertility and difficulties to obtain capital to start vegetable production. Kedarpan, a middle dry land with main commodity being cassava, faced problems of insufficiency farm income to meet daily needs and lacked of job opportunities outside farming. Sumilir, a low wet land with main commodity being paddy, faced problems of decreasing soil quality and frequent rat-attacks.

Case of Serang

To overcome the problem of budget constraint, there were on-going efforts to mobile resources to develop physical infrastructure in Serang. The village head tried as much as possible to involve villagers in the meeting.[5] Meetings between village head, parliament head and development committee head were periodically conducted, at least once in 2 months. List of meeting attendance in some project reports (Serang Village Government 2010) presented that many villagers are indeed invited.

Most of villagers perceived that the village head was generous. The example was the case of village office reparation in 2008. Due to severely damaged, the office could not function for administration tasks. According to raw calculation of village development committee, full reparation could only be done within two fiscal years, as one annual budget was not sufficient. Surprisingly, the village head said that he was willing to provide the additional money needed for completed reparation from his own pocket so that the reparation could be finished just within 1 year, as far as villagers agreed to reimburse it in the following year. Through the meeting, the idea was agreed and the reparation could be started. Thus, in Serang, combination of the

[4] Interview with the head of Sumilir village development committee in January 18th, 2012 and the head of Kedarpan village development committee in February 23rd, 2012.

[5] Interview with the head of Serang village in February 2nd, 2012.

popularity of village head and the strong communication strategy of rural institutions made resource mobilization a much easier exercise for the community.

The land area of Serang was also much larger than the other villages, implying that its infrastructural needs were higher. In order to get more funds from the government, there was idea to split Serang into two new villages. A formal letter to propose the partitioning of the village was sent to district government, and village head together with village parliament lobbied the district government to approve the initiative.

With regard to the problem of decreasing soil quality, as acknowledged by village head and village officers, not much effort had been made to deal with it. The problem was deemed to be out of the capacity of villagers, and it should be the tasks of district government. Some individual farmers utilized organic fertilizers from beef and chicken feces to normalize soil quality. However, the utilization of organic fertilizers was difficult to be promoted since the supply was sometimes stopped due to stock limitedness from producer.

Some progress was made in their effort to improve farmer's access to credit. In 2008, the village received grant from National Program of Community Empowerment (NPCE) amounting to about IDR 100 million. The village government used the funds to establish a borrowing and lending cooperative, from which the villagers could borrow money without collateral. The cooperative was performing quite well. Yet, there were some challenges in lending money to villagers. Due to constraint of fund, the loan amounts were relatively small. The maximum amount of loan was only IDR 5 millions, which was still less far than enough to cover even input costs for vegetable production.

Case of Kedarpan

Different from Serang, Kedarpan village applied a representation meeting. Documentary study and participant observation find that the attendant of the meetings mostly consisted of neighborhood heads and development committee members.[6] There was no routine meeting among the rural institution heads. Rather, the meetings were conducted per need of the community.

Although the village head applied a representation meeting, hamlet and neighborhood heads were functioning well in disseminating the information regularly to community. This way, cash and labor could be mobilized without many difficulties.

In order to get more access to district budget, Kedarpan village head collaborated with some district parliament members from this area. Entrusting development proposals in district parliament members was believed to have great chance of securing funding from district budget rather than the village head himself submitting to the district government.

With regard to the problem of insufficient income from farming, it was the view of the village head, village parliament and village development committee that there

[6] Conducted in Kedarpan on March 19th, 2011.

was no much they can do. It was argued that income of farming households would be much enhanced if they changed from cassava to other crops as their main crops. Indeed, farmers in this village had an experience of benefitting from government seed distribution program of durian (*Durio Zibethinus*) about 10 years ago in order to raise their income.[7] However, the farmers gave limited care to this crop, and most of the plants died and the program failed.

Apart from attempts to switch crops from cassava to other crops with higher economic value, no efforts had been made to identify feasible ways of providing job opportunities for the villagers. Most villagers expected the government to create jobs for them by attracting the investors. Others expected the government to train the youth of the village as mechanics to make them employable. However, it was noted that these demands were beyond the capacity of village government. Attracting investors was the responsibility of district government, and the idea of delivering training to the youth had never been the priority in the village budget. Village government could, however, improve the livelihood of villagers by allocating a portion of village budget to the borrowing and lending group in this village. Documentary study shows that in 2010, the village government transferred capital assistance to women lending group as much of IDR 10 Million (Purbalingga District Government 2010). Further, in order to facilitate job-seeking activities among the youth, village officers could put in place a simplified procedure in obtaining recommendation letters from the village office to ensure hassle-free job-hunting.

Case of Sumilir

In Sumilir, the mobilization of resources was somehow problematic. The village head, village parliament and village development committee were all of the opinion that it was always difficult to reach consensus with villagers. For example, it took a very long discussion just to decide the type and the location of project. From the perspective of village head, he felt that his position on development issues was always challenged by some villagers.

Some villagers revealed relatively different information. Some villagers feel uncomfortable with the high number of familial relationship within village officers. In fact, it was found that five officers in the village office had familial relationship in the form of father and son or son in law. Further, the village head and the head of development committee had their son and daughter, respectively, married to each other. Therefore, in village meeting, villagers often put up different opinions with village head in order to ensure that the village decision was fair to all the villagers.

The district office often received anonymous letters from villagers to complain about the actions of the village head.[8] This strained relationship influenced the possibilities of success of Sumilir village in overcoming local problems. Although there were less direct responses from the district government to these anonymous

[7] Interview with the head of Kedarpan village in January 12th, 2012.

[8] Interview with the secretary of Kemangkon sub-district in January 28th, 2012.

mails, reluctance on the part of district officers to accept the proposals submitted by Sumilir village might arise due to the fact that officers might not be sure that the project would be smoothly executed.

With regards to the problems on decreasing soil quality, just like Serang village, village government could not do much to overcome this menace. They actually understood that fallowing the land in one planting period might recover soil fertility. However, fallowing the land was not feasible for many farmers because it would mean forfeiting their earnings from the farming.

To overcome rat-attacks, farmers, coordinated by hamlet heads, periodically conducted rat hunting. District government distributed rat poison, firecrackers and other tools needed to exterminate the rats. Even though it was not completely successful, this method helped in decreasing population of rats and consequently decreased the damage in paddy harvest.

10.5.4 Capacity Development for Rural Institutions

On paper, Purbalingga district government, as written in its Medium Development Plan, prioritized efforts to improve the capacity of village government for successful rural development (Purbalingga Local Planning Agency 2006). Documentary study on annual district budget finds that, in order to develop the individual capacity, two village officers from each village government were invited for training. The duration of training was usually 3–5 days, with trainees reoriented on new regulations, letter and archival matters and financial administration. To strengthen the organizational capacity of village government, the district government distributed motorcycles and sets of computer to village offices. The software on demographical registration and financial administration were provided along with training of the operators.

Despite training on administration matters, technical training to address livelihood problems were very limited. For example, training on agriculture and other livelihood skills for the rural institutions as well as the villagers were very rare. There was also no equity in the deliverance of capacity development. The district government focused only to develop the capacity of village officers. Village parliament, neighborhood head and village development committee were neglected, in which the district government had neither trained nor provided capacity development to them. Although previous sections presented that village parliament, neighborhood group and village development committee had capacity to conduct their functions, their existing competencies were not a result of training but learning by doing.

Moreover, capacity development was not only about training, but also by giving opportunities for village governments to perform more tasks on rural development. With regard to transfer of tasks on rural development, the district government issued several regulations in order to provide legal framework of village government authority. One of the most important regulations is District Regulation 21/2007,

which regulated what types of tasks were transferred to village government. Among others, the tasks transferred to village governments were tasks to develop rural small irrigation, feeder roads, village polyclinics, kindergarten, sanitation and other small scale infrastructure. Yet, this regulation was not followed by deliverance of sufficient fund transfer to village government. The portion of district budget given to village government was still low, constituting only about 5 % of total district budget (Purbalingga District Government 2010).

10.6 Discussion

Findings of this study are generally in line with the argument of Bebbington (1999), who states that good capacity does not always result in the good performance due to complex social cultural factors determining the capacity realization. The cases in Serang, Kedarpan and Sumilir suggest that the success in overcoming livelihood problems is significantly influenced by how the village heads exercise their power. Thus, leadership capacity matters. Having the highest capacity scores of village head, Serang village can achieve relatively better result in addressing livelihood problems.

Perhaps, the most general problems hampering capacity realization is weak coordination due to serious power imbalance among the institutions. Through decentralization policy, the central government has brought a structural change by introducing village parliament in rural institutional setting. Yet, the establishment of village parliament is still not able to make the power within the village more balanced. Power relations between village head, village parliament and village development committee is not working as it is arranged in the village structure. The village heads, supported by the village officers, still dominate the village politics and delimitate the other institutions such as village parliament, village development committee and neighborhood heads from performing their functions of both putting check and balance in village administration or demanding an equal position in village meetings. The village parliaments tend to align themselves with the village head while the village development committees position themselves as subordinates to village heads.

These general problems are particularly interested to refer to the relationships between power and local culture. Given the local Javanese culture in seeing the village head as the father of the community and that the traditional power should be followed obediently, the village governance during decentralized period has been not changed much from traditional governance system. Since decentralization requires that all rural institutions do their tasks and work together in the village governance without cultural barriers, the dominance of village head has, to large extent, hampered the success in solving local problems.

The other factor contributing to the persistence of power imbalance is less attention from the district government to village parliament, development committee and neighborhood heads. It was only village head and his officers who get salary and the logistics. Village parliament, development committee, and neighborhood groups are

voluntary jobs receiving no incentives. Thus, it would be difficult to expect total devotion from them. Capacity development is also delivered only to village head and officers. Village heads are the only institution legally accepted to represent the village with any outsiders, particularly district government. Thus, only village head who can develop network with the outsiders. He has the best capacity among rural institutions. Other institutions including the village parliament, development committee and neighborhood heads struggle by themselves to understand the complex issues of decentralization.

10.7 Conclusions and Policy Implication

Four rural governmental institutions consisting of village officers, neighborhood group, village parliament, and village development committee are analyzed in this study. In general, each institution has good enough capacity to implement its respective functions in rural development. However, weak coordination among rural institutions is the major problem found in all study sites that hampers the utilization of institutional capacity to address local problems. Village head, culturally the highest patron in village, was still too dominant and delimitating the other institutions to perform their tasks. Such condition was exacerbated because district government put emphasis on capacity development of village officers at the expense of neighborhood group, village parliament and village development committee.

If the structural change brought by decentralization cannot reduce a power domination having been culturally embedded, effort to make more balanced power relation, and hence more successful decentralization, should be focused on personal empowerment through capacity development. Thus, this study recommend the government to conduct capacity development for village parliament, development committee and neighborhood heads. This can be done through socialization of the regulations and training to facilitate dialogue, public hearing and development planning. Apart from those trainings, technical training to address the livelihood problems, for example, in agriculture and environmental matters, are also recommended.

References

Alatas V et al (2001) Voice lessons: local government organizations, social organizations and the quality of local governance. The World Bank Indonesia, Jakarta

Antlöv H (2000) Village governance in Indonesia: past, present and future challenges. Paper presented at the conference of dynamic of local politic in Indonesia, Yogyakarta, 3–7 July 2000

Antlöv H (2003) Village government and rural development in Indonesia: the new democratic framework. Bull Indonesian Econ Stud 39(2):193–214

Aref F et al (2009) Assessing community leadership factor in community capacity building in tourism development: a case study of Shiraz, Iran. J Hum Ecol 28(3):171–176

Bebbington A (1999) Capitals and capabilities: a framework for analyzing peasant viability, rural livelihoods and poverty. World Dev 27(12):2021–2044
Bebbington A et al (2006) Local capacity, village governance, and the political economy of rural development in Indonesia. World Dev 34(11):1958–1976
Blair H (2000) Participation and accountability at the periphery: democratic local governance in six countries. World Dev 28(1):21–39
Central Java Local Planning Agency (2010) Analysis on poverty alleviation in Central Java province. Local Planning Agency, Semarang
Chetri AK et al (2007) Intervention on livelihood management through community based organization: case of rural Nepal. J Int Dev Coop 13(1):187–206
Cohen JM, Peterson SB (1997) Administrative decentralization: a new framework for improved governance, accountability, and performance. Harvard Institute for International Development, Cambridge
CSA (2010) Trend of selected socio-economic indicators of Indonesia 2010. CSA, Jakarta
Dharmawan L (2002) Dynamics of local capacity and village governance: findings from the second Indonesian local level institutions study. The World Bank Indonesia, Jakarta
Evers PJ (2000) Resourceful villagers, powerless communities (rural village government in Indonesia). The World Bank Indonesia, Jakarta
Goodman R et al (1998) Idenfiying and defining the dimension of community capacity to provide a base for measurement. Health Educ Bahav J 25:258–278
Hadiz VR (2004) Decentralization and democracy in Indonesia: a critique of neo-institutionalist perspectives. Dev Change 35(4):697–718
Irawanto DW (2011) Exploring paternalistic leadership and its application to the Indonesian context. Massey University, New Zealand
JICA (2004) Capacity development: handbook for JICA Staff. JICA, Tokyo
Johnson C (2001) Local Democracy, democratic decentralization and rural development: theories, challenges and options for policy. Dev Policy Rev 19(4):521–532
Joshi NM, Maharjan KL (2007) Institutional changes in forest resource management and change in forest coverage in Nepal. J Int Dev Coop 13(1):231–252
Jutting J et al (2005) What makes decentralisation in developing countries pro-poor? Eur J Dev Res 17(4):626–648
Kedarpan Village Government (2010) Final report of village allocation fund (VAF) of Kedarpan village 2010. Kedarpan Village Government, Purbalingga
Mizrahi Y (2004) Capacity enhancement indicators. World Bank Institute, Washington
Mulder N (1996) The ideology of Javanese-Indonesian leadership. In: Antlöv H, Cederroth S (eds) Leadership in Java: gentle hints, authoritarian rule. Curzon, Great Britain, pp 57–72
Parker AN (1995) Decentralization: the way forward for rural development?. World Bank, Washington
Purbalingga CSA (2011a) Karangreja sub-district in figure, 2010. Purbalingga CSA, Purbalingga
Purbalingga CSA (2011b) Kejobong sub-district in figure, 2010. Purbalingga CSA, Purbalingga
Purbalingga CSA (2011c) Kemangkon sub-district in figure, 2010. Purbalingga CSA, Purbalingga
Purbalingga District Government (2010) Document of Purbalingga district budget 2010 (Mimeo). Purbalingga District Government, Purbalingga
Purbalingga Local Planning Agency (2006) Medium term development plan of Purbalingga, 2006–2011. Purbalingga Local Planning Agency, Purbalingga
Ranis T, Stewart F (1994) Decentralization in Indonesia. Bull Indonesian Econ Stud 30(3):41–72
Ricketts KG (2005) The importance of community leadership to successful rural communities in Florida. Ph.D. Unpublished Dissertation, University of Florida, Florida
Rondinelli DA, Cheema GS (2007) From government decentralization to decentralized governance. In: Rondinelli DA, Cheema GS (eds) Decentralizing governance, emerging concepts and practices. Brookings Institution Press, Washington, pp 1–20
Scoones I (1998) Sustainable rural livelihoods: a framework for analysis. Institute of Development Studies, Brighton

Serang Village Government (2010) Final report of village allocation fund (VAF) of Serang village, 2010. Serang Village Government, Purbalingga
Smoke P, Lewis BD (1996) Fiscal decentralization in Indonesia: a new approach to an old idea. World Dev 24(8):1281–1299
Sumilir Village Government (2010) Final report of village allocation fund (VAF) of Sumilir village, 2010. Sumilir Village Government, Purbalingga
Takeshi I (2006) The dynamics of local governance reform in decentralizing Indonesia: participatory planning and village empowerment in Bandung, West Java. Asian Afr Area Stud 5(2):137–183
Tinker I, Walker M (1973) Planning for regional development in Indonesia. Asian Surv 13(12): 1102–1120
UNDP (2002) Capacity for development, new solution to old problems. Earthscan Publications Ltd, New York
Uphoff N (1985) Local institutions and decentralisation for development. In: Hye HA (ed) Decentralisation, local government institutions and resource mobilisation. Bangladesh Academy for Rural Development, Bangladesh, pp 43–78
Uphoff N (1986) Local institutional development: an analytical sourcebook with cases. Kumarian, West Hartford
Uphoff N (2004) Local communities and institutions: realizing their potential for integrated rural development . In: Wijayaratna CM (ed) Role of local communities and institutions in integrated rural development. Asian Productivity Organization, New Zeland, pp 63–84
Uphoff N et al (1998) Reasons for success: learning from instructive experiences in rural development. Vistaar Publications, New Delhi
Velsink IS (1996) Traditional leadership in rural Java. In: Antlöv H, Cederroth S (eds) Leadership in Java: gentle hints, authoritarian rule. Curzon, Great Britain, pp 33–56
Widianingsih I (2005) Local Governance, decentralization, and participatory planning in Indonesia: seeking a new path to a harmonious society. In: Ahmad R (ed) The role of public administration in building a harmonious society. ADB, Philippines, pp 69–89
World Bank (2006) Making the new Indonesia work for the poor. The World Bank Indonesia, Jakarta
World Bank (2007) Spending for development: making the most of Indonesia's new opportunities. World Bank, Washington

ERRATUM

Capacity of Rural Institutions in Implementing Decentralized Development in Indonesia: Case of Three Villages in Purbalingga District, Central Java Province

Sutiyo and Keshav Lall Maharjan

K.L. Maharjan (ed.), *Communities and Livelihood Strategies in Developing Countries*,
DOI 10.1007/978-4-431-54774-7_10, © Springer Japan 2014

DOI 10.1007/978-4-431-54774-7_11

The publisher regrets that an author's affiliation appeared incorrectly in Chapter 10. The authors' affiliations should be shown as follows.

Sutiyo (✉)
District Government of Purbalingga, Central Java Province,
Indonesia Purbalingga District, Indonesia
e-mail: sutiyobanyumasan@yahoo.com

K.L. Maharjan
Graduate School of International Development and Cooperation,
Hiroshima University, Hiroshima, Japan

The online version of the original chapter can be found at
http://dx.doi.org/10.1007/978-4-431-54774-7_10

Index

K.L. Maharjan (ed.), *Communities and Livelihood Strategies in Developing Countries,*
DOI 10.1007/978-4-431-54774-7, © Springer Japan 2014